Engineering Council of India

6th National Conference on Re-engineering Engineers

November 28, 2008

Main Auditorium
India Habitat Centre, Lodhi Road, New Delhi

Souvenir

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6th National Conference
Theme : Re-engineering Engineers

Preamble

It is often said that the current engineering education system does not prepare engineers for the role of project engineers and managers. Engineers need a familiarity with the world of business and commerce, dealing with people and resources, environmental, health and safety aspects, legal aspects, project, logistics and procurement engineering, application of IT and communication technology, learning the finer elements of contracts and claims, apart from the changing world of technology itself. All engineering activities have economic implications. Engineers need to be able to analyse the economic aspects of engineering applications. This empowers engineers to make well-reasoned decisions in analyzing personal decisions as well as business, technology and informed conclusions about public policy based on a comprehensive analysis of costs and benefits of alternatives. The present and constantly evolving economic and business environment need project leaders. For this, engineers today have to be multi-skilled. Trends across the world depict the rise in demand for re-engineering engineers for meeting the needs of the industry.

Engineers, who come out of engineering colleges, are engineering discipline-specific and do not have sufficient knowledge to start working straightway on their jobs in an industrial unit. We have working engineers who often get stuck up in the domain-specific jobs and do not move out to acquire multi-skills required today for meeting the changing needs of the engineering profession. We, therefore, need re-engineering of both working engineers and graduate engineers. We also have potential engineers in persons holding diploma in engineering. They need re-engineering to tap their engineering potential for meeting the rising demand of engineers. We have, at the base level, technicians. They are also persons with engineering potential. We need to re-engineer them as well.

The 6th National Conference on the theme Re-engineering Engineers is being organized to consider these issues in depth for evolving a working strategy and system for re-engineering of engineers. A greater impetus to this cause can be provided if the leaders of Indian industry, professional associations/societies/institutions coupled with academic establishments like IITs, NITs, etc, join hands for tackling these issues.

Engineering Education needs Re-engineering

Engineering has emerged as a multi-task profession. Mere training in compartments of different disciplines is not considered suitable to industry today. The problem in the engineering education in India is that things have not changed during the last three decades. Some of the concepts that are being taught and topics and subjects that are in the curricula are quite outdated. There is too much of pure sciences and mathematics with no clear idea of their relevance to applications. While too much theory is taught, too little emphasis is given on experiments and on-the-job training. There is no solid interdisciplinary base. There is too much of the compartmentalization. Students have no idea as to what they are studying and what they are going to do. An engineer, after passing out, enters industry and then only he/she is trained there for meeting his/her job requirements. There is, therefore, no correlation in the present engineering education system between theory and practice. Technology today has become more interdisciplinary. There is no subject which can make you understand technology in its entirety; it needs interdisciplinary skills and knowledge to understand and comprehend.

The basic challenges of the engineering education are the ever-changing world of engineering which demands a new way to educate future engineers. So, the engineering curricula should encompass effective use of computer tools, a greater variety of organizational work contents, management concepts, basic concepts of economics, statistics, basic concepts of other disciplines, etc. As a matter of fact, since the last decade the engineering profession has become more interdisciplinary. Seamless transition in the engineering education has, therefore, become important. This cannot be ignored and keeping status quo in the engineering education cannot be afforded in the given circumstances.

Engineer should also have sufficient knowledge of other disciplines such as finance, law, dispute redressal, computer applications, public relations, team dynamics, HRD, management skills, etc. The latest example of seamless engineering can be found in the emergence of a new multidisciplinary nano-science and technology and in the Aeronautical Engineering. An effective interaction between academia and industry is also required for producing practising engineers.

According to the August, 2006 issue of Business India, USA produces more engineers despite having less number of universities and around a little more than half of its population when compared with India. Primarily, it is because USA produces more general engineers and India does not. A definite trend in the world of knowledge creation and its dissemination can be seen quite clearly today which is essentially a trend towards convergence and indivisibility. Whatever we may do with regard to re–engineering, the engineering curricula for which a lot of ideas have been thrown up like, campus-corporation collaboration, institute-industry interaction, we want reflective practitioners. Academicians should make a temporary transition to the world of work from the world of teaching. Any change, that we may want in the conventional practices, cannot be done through legislation. It can be better and quicker done through credible consensus-building process. This is what this convention on the Seamless Engineering, organized by the Engineering Council of India is trying to realize.

Source : *The Indian Engineer, September 2008.*

The Indian industry today is generally of the view that engineers, who come out of colleges, are not suitable for them. The Industry does not provide information to the academia about what they expect from the passing-out engineers. There is no interactive mechanism in place between the two. This is the problem. Industry-academia interaction mechanism abroad is well established to the extent that professors become with their position in the academy (an academic institution) automatically the top most industrial consultants. There is, therefore, a need (for us) to put in place such a mechanism for synchronizing what we need to teach students so that they can meet the needs of industry. It is only then that it would be possible for both the stakeholders to come to common understanding as to what engineering curriculum needs to be taught. If we are perhaps able to create this synergy between the industry and the academia, the need for the seamless engineering will get more prominence.

In order to meet the present requirement of industry, a student, who wants to finish engineering with general engineering, should be able to do so and enter industry as an engineer after three years of engineering course. A student, who wants to branch out into various special streams of specialization, should be able to do it during the subsequent two years, i.e., during 4th and 5th year of the course. We should, therefore, have general engineering course and produce general engineers who could do any kind of job. Specializations can also be done at the undergraduate level itself with two years' more course in continuity of the three years of general course. Alternately, it could be a general course of three years and two years of specialization thereafter - either in continuity or with a break of two years which can be spent in an industrial unit. Another alternative could be four years of general engineering course at the undergraduate level and two years' course in particular specialization at the postgraduate level. In this alternative also there could be a break of two to three years for taking up employment in an industrial unit. We can select the required alternatives.

Creating seamless thinking primarily is the responsibility of the professional bodies. They should discharge this responsibility. Engineering Council of India has taken the first step by organizing thought-provoking, apt and timely national conventions and the 6th National Conference being organized at New Delhi on November 28, 2008 will further look at this subject closely.

Strategy for action is that the professional guilds, institutions and the Engineering Council of India should join hands and evolve a workable curriculum. Industry must spell what to be taught; the professional guilds should validate it and adopt continuous professional development.

Technical Papers

Contents

"Re-engineering Present day Competencies by Design and Development Change" Experience of TCS with graduate engineers

Over the past decade, IT industry was chosen as a career option by many engineers from diverse disciplines. The number of engineers recruited by TCS has been steadily increasing in tune with the growth in business. In fiscal 2007-08, TCS has selected over 22,500 engineers from various campuses spread across the country.

The selected candidates are not 'project ready'. They are put through an intensive 2 months induction program whose main objective is to give them an industry-orientation. The program is designed by the Learning & Development team of TCS in close consultation with key stakeholders such as project leaders, business development managers, and technology experts' group.

On an ongoing basis, the performance of the candidates in the induction program is analyzed in detail. It is used to :

- Provide feedback to academic institutions across the country
- Make critical decisions in choices related to the hiring process
- Revise the training content

During this session, TCS would be presenting some key findings from the analyses.

Re-engineering Graduate Engineers for Consultancy Profession

Dr. Ing. N Rajagopalan*

Abstract

Engineering education has to be considered under two basic concepts namely creating a knowledge base in the concerned area of specialization to the minimum required level and secondly the application of the same in profession with the aim of the purpose of the profession. In research and academic field, the purpose of the profession is to go in to fundamentals of the knowledge base and look for the scope for improvement with advances in science and Technology. The same in consultancy profession is to give information to the clients and facilitate economically viable and aesthetically pleasing solutions acceptable for society with in a span of time. The same will be different for construction engineering and contracts though there may be some common aspects amongst all.

The present education system tries to provide only the first part namely, the knowledge base and the second part is left to the candidates to learn it during professional experience itself. It is desirable to give an insight of the same even when the candidates complete their program and enter in to the profession. This presentation details out how the engineering curriculum has been modified over years leading to the lacunae in the existing system and also a possible solution to remove the lacunae.

Engineering Curriculum

Over the past four decades, curricula leading to engineering degree in various universities have been modified with an intention of updating. These modifications have not been dealt in a holistic approach. The modifications were both with respect to time and course content. The modifications with respect to time were at the behest of ministry of education and an Indian council for technical education. Both these government organizations were concerned about budgeting and expenditure and providing facilities for more number of aspirants. Accordingly, around 1965, after the plus 2 education system was introduced, the total number of years of education before getting an engineering degree was reduced by one year, leading to reduction in the curriculum. This is with main intension of reducing the budget/cost and providing facilities of education for more aspirants.

With the advent of space and information technology, there was a need for more knowledge on numerical mathematics, physics and other basic sciences which was understandable. The universities and technical administrators considered this need and arranged to introduce more credits for such type of education in engineering at the cost and risk of engineering subjects or professional courses without increasing the duration of the course.

To cover up these lacunae, engineering curricula of the western world and syllabus were cited and were taken as guidance. The number of courses in engineering subjects was reduced very much. Many

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useful courses for practicing profession were grouped in to electives and the students were allowed to take the desired subjects. The students always chose subjects which need minimum application and provide for maximum marks. Hence knowledge is also given a go by.

But in western world, the students can choose any type of subjects and correspondingly choose a job suiting to their knowledge base.

In Indian context this kind of luxury was not available and hence they had to take a generalized degree with which they can go for any job.

A comparison of the modification of curriculum over 4 decades is presented. This is not the exact version. This has been drawn as averaged out curriculum of different technical universities inclusive of IITs.

Curriculum for Civil Engineering Graduates

Category	Credits prior to 1965	Credits : 1965 to 1990	Credits after 1990	Credits after 2000
Humanities	Nil	18	27	10 or 12
Basic Science	40	59	58	29
Basic Engg.	42	30	24	22
Professional Engg.	100	66	63	77 or 80
Electives	Nil	12	12	24
TOTAL	**182**	**185**	**184**	**162 or 167**

Note : These numbers (credits) have been arrived at on an average and does not reflect on any one University curriculum. Hence they are only guiding factors.

Curriculum Lacuna For Infrastructure Consultancy Profession:

Topographic survey is an area which is to be known to civil engineering graduates and this kind of survey only leads to details of land acquisition, replacement and relocation of service lines in case a project is proposed in an area. This is a field oriented practical subject. When four semesters with 12 credits are allowed for practical surveys in ester years (earlier to 1965) it has been reduced to one semester with 3 credits in 1995. With more number of students in the class, hands on application on equipments like total station have become impossible.

Quantity surveying is another subject which leads to information on minimization of cost. Construction methodology, Inventory of materials and similarly many other field oriented subjects such as Aerial surveys, Geometric Information System called GIS, which were having an important role in curriculum earlier were later pushed into elective subjects. Students give minimum importance for such useful subjects at the university levels.

With the advent f computers, computer oriented subjects got greater importance and students choose electives which are more computer oriented thinking that these exposures will give them greater job opportunities. Students were not inclined to take professional oriented subjects as mentioned above.

As a direct outcome of this, the next generation of faculty who are chosen from the sample of these student populations (of present years) also will not have any knowledge of the above and slowly these areas are vaning in the civil engineering curriculum. While there are many more lacunae only a few of them are bought in to attention of this audience.

Requirements

With the opening of liberalization and international business houses coming to India, the infrastructure construction companies have taken a lead in Public Private Partnership and number of projects have been floated on BOT / PPT project modes. These require additional information for the engineers for successful commissioning of the projects. These information are spread over the areas of business and commerce, human resources planning, material resources planning, environmental health safety aspects, legal aspects, logistics for the progress, quality and documentation application of IT and communication technology. This can be introduced as part of the curriculum at higher levels after creating an engineering base for the students.

The following courses could be planned :

- Project Proposals & Feasibility Study
- Preliminary surveys [Topography, Geotechnical, etc.,]
- Socio-Economic aspects in Project Planning
- Environment Assessment and Management
- Construction Methodology Planning & Equipment
- Construction Management
- Logistics of works and Inventory Management
- Human Resources Planning and Management
- Cost Analysis of projects
- Project Monitoring with MIS
- Finance Engineering
- Statutory Regulations for Companies with Labour Involvement
- Contracts, Contract Management inclusive of Legal issues.

Suggestions and Recommendations:

With the present system of variety of jobs in perspective, for the civil engineering graduates, it is not reasonable to include them in the basic curriculum leading to engineering degree but introduce a

special level course for new recruits or call for minimum understanding of the subjects for serving the engineers. This can be termed as a professional engineering program. This should lead to a diploma in P.E. (Professional Engineering). All professionalists have to have a qualification called P.E. which covers up the topics mentioned above.

Those who are having only the basic engineering degree may not be allowed to practice profession but only support the professional engineers with their activities. This is similar to a professional law degree for practicing profession or professionals who go through an internship with a period of 6 months in case of Doctors. The syllabus could be drawn by the University / Professional Engineers and get approved in the Syndicate or University or Engineering Council for practicing engineers.

The topics mentioned above will have about 30 credits and each credit can be covered in 15 contact hours totalling to 450 hours. Allowing for 30 hours per week, these programs can be covered in 15 weeks which is equivalent to one semester in any university if taken as a regular program. The professional engineers can be allowed to take 6 credits in a distributed pattern if they are already employed and these courses can be given by a recognized statutory bodies like Universities and professional forum.

Re-engineering Graduate Engineers

*K Lalitha Prasad**
Suresh Panampilly

1. Abstract

Over the past decade, IT industry was chosen as a career option by many engineers from diverse disciplines. The number of engineers recruited by TCS has been steadily increasing in tune with the growth in business. In fiscal 2007-08, TCS has selected over 22,500 engineers from various campuses spread across the country.

The selected candidates are not 'project ready'. They are put through an intensive two-month-induction program whose main objective is to give them an industry-orientation. The program is designed by the Learning & Development team of TCS in close consultation with key stakeholders such as project leaders, business development managers, and technology experts' group.

On an ongoing basis, the performance of the candidates in the induction program is analyzed in detail. It is used to:

- Provide feedback to academic institutions across the country
- Make critical decisions in choices related to hiring process
- Revise the training content

Some key findings from the analyses are presented in this paper.

2. Introduction

Tata Consultancy Services Ltd. (TCS) is the largest software house in India. It started as a pioneering venture of TATA Sons in 1968. Today it has emerged as the Asia's largest IT Services and Solutions Company and is among the top 10 in this category worldwide. The revenue earned by TCS in 2007-08 was USD 5.7 Billion. It had 1, 07,698 employees at the end of 2007-08. The year saw a net addition of 22,116. The number of fresh engineering graduates inducted into TCS during 2007-08 was over 12,000.

TCS has pioneered several key innovations such as the 'Onsite- Off shore model' which later became the mantra for India's development as an IT hub. It has set up an R&D centre for software as early as 1981, at a time when the IT industry was in its infancy in India.

TCS has seen rapid growth in revenue and employee strength (see Tables 1 and 2). The growth in revenue during the period '96-97 to '07-08 was 31.45 times. This growth was achieved with an 11.33 times increase in employee strength. Increase in employee productivity has been a key driver in the growth of TCS.

Fresh graduates inducted into the organization from campuses across India have contributed significantly to the growth of TCS.

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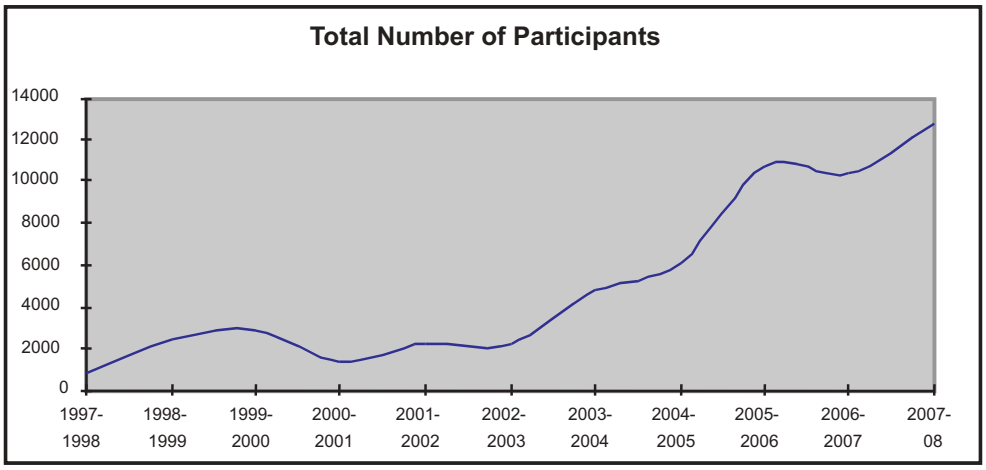
Table 1

Financial Data		
	Revenue in INR Crores (Total Revenue)	**Revenue in USD Million (Total Revenue)**
March 1997	721.00	204.62
March 1998	1,083.00	291.65
March 1999	1,690.00	402.06
March 2000	2,115.00	489.30
March 2001	3,142.00	688.59
March 2002	4,187.00	879.61
March 2003	5,012.00	1,040.48
March 2004	7,122.00	1,560.02
March 2005	9,727.00	2,169.55
March 2006	13,252.15	2,991.92
March 2007	18,633.20	4,286.45
March 2008	22,861.40	5,700.39
Q1 2009	6,410.70	1,525.00
Q2 2009*	6,953.40	1,574.00

Table 2

Number of Associates			
March 1997	9,500	March 2004	30,000
March 1998	10,500	March 2005	40,992
March 1999	12,100	March 2006	62,832
March 2000	14,300	March 2007	85,582
March 2001	16,800	March 2008	1,07,698
March 2002	19,000	Q1 2009	1, 12, 593
March 2003	22,000	Q2 2009*	1,17,921*

The following chart shows the number of fresh graduates who joined TCS between '97-98 and '07 - '08.



Source : TCS ILP Internal Database

3. Induction process at TCS

In the initial years of TCS, fresh graduates joined at the branches where they would work. The induction at the branch covered the technical training and important processes in the organization.

With the increase in number of fresh graduates joining, the organization created a unit to handle induction as a central process. Fresh graduates joined at an induction centre. The program was residential. The elements of induction training were Software Engineering, Foundations of computing, Organizational processes and Soft skills (which included English oral and written communication).

The growth of TCS saw increased business with non-English speaking customers. Facility to work in a multi-cultural environment was required as a competency in the organization. Graduates were given initial training in French, German or Japanese.

Until 2005-06, the technical component of the induction program covered generic competencies required across the vast majority of projects in the organization. However, the scale of training required in specific technology areas has been steadily increasing through the years. In 2005-06, TCS decided to include stream training (Training in technologies used in projects) in the induction.

4. Analysis of Performance

Performance of trainees during induction is monitored. Feedback is shared and suggestions for improvement, if any, are given. TCS has regular interactions with academic institutions. These interactions cover feedback on performance of their graduates. Possible lines of action of mutual benefit are discussed.

Competencies measured

The parameters on which the performance is measured are :

- Common training (which measures the ability to assimilate programming and software engineering concepts)

- Oral and written communication skills (before and after induction)
- Stream training (which measures the ability to grasp technology concepts)

The analysis of performance of trainees who joined TCS during January-December 2007 is summarized in the following sections.

Scales used for measurement

Tests are conducted to measure the technical proficiency attained at the end of common training and stream training. Performance index (on a scale of 0-50) is used to measure the competency of a group. Appendix-1 gives details of performance index calculations

Tests are conducted to measure the competency in English oral and written communication. Trainees are placed in one of the 5 levels, that is, Level 0 to Level 4. Appendix-2 gives details of these levels.

Summary of performance analysis

Tables 3 to 7 give comparative performance indices for various categories of trainees.

Table 3

UU Vs PG	No	% No	Avg. Score	Performance Index
UG	9,232	83%	60.79	26.66
PG	1,847	17%	61.71	28.06

Table 4

CS Vs Non CS	No	% No	Avg. Score	Performance Index
CS	5254	46%	61.84	27.97
NonCS	6206	54%	60.33	26.21

Table 5

Source	No	% No	Avg. Score	Performance Index
Campus	6486	58%	62.79	29.67
DT	4786	42%	58.56	23.34

Table 6

Gender	No	% No	Avg. Score	Performance Index
Female	4151	36%	60.78	26.73
Male	7309	64%	61.16	27.17

Table 7

Region	No	% No	Avg. Score	Performance Index
North	1933	17%	62.06	28.60
West	2169	19%	63.82	30.77
East	1119	10%	60.47	26.10
South	6235	54%	59.83	25.38

Following conclusions can be drawn from the above:

- There is no significant difference in the performance
  - Between graduates and post graduates
  - Between graduates of computer science and related disciplines and those of core disciplines
  - Between genders
  - Between graduates from different regions
- Graduates selected in campus have performed better than those selected in off-campus drives. This can be attributed to the difference in quality of education between the colleges accredited by TCS and other institutions.

Table 8 gives the distribution by percentage :

Table 8

Poor	66 %
Average	31 %
Good	3 %

Table 9 gives the distribution by region :

Table 9

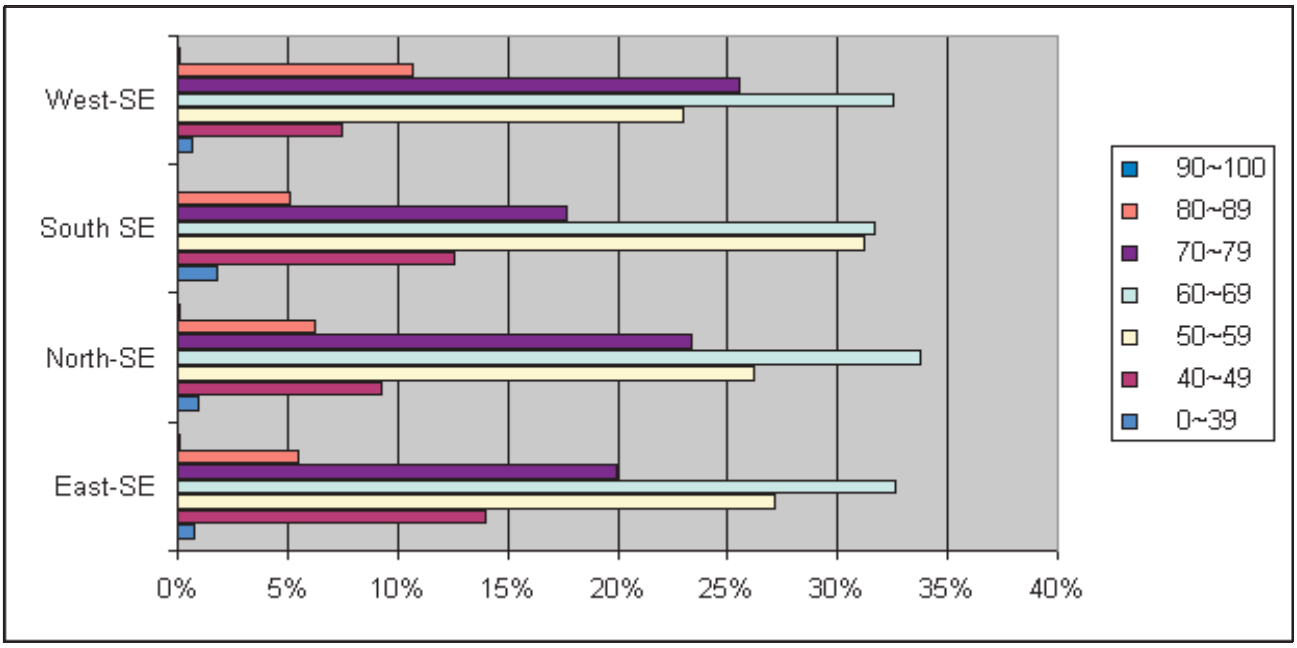
	Good	Average	Poor
East	1%	38%	61%
North	1%	36%	63%
South	1%	31%	68%
West	2%	32%	66%

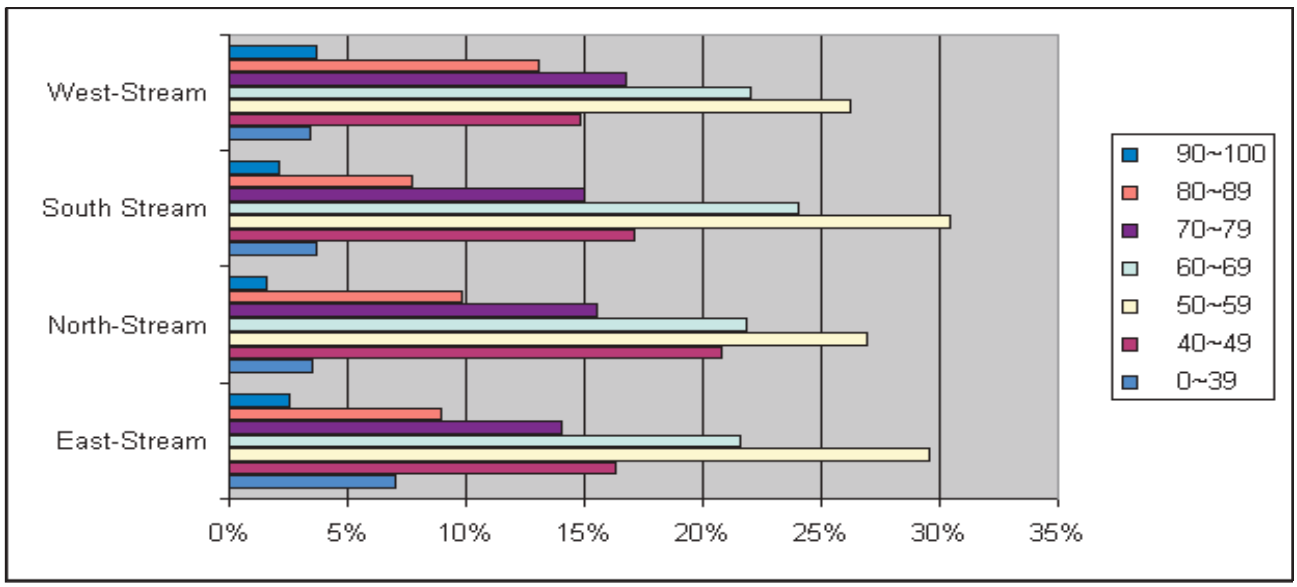
Following conclusions can be drawn from the above:

- There is a strong need to improve the ability to communicate (Oral & written)
- There are no major differences in the communication ability of graduates across different regions

Learnability of fresh graduates

The charts given below summarize the performance of trainees in the common training and stream training (both have duration of one month, with the stream training following the common training)





Most of the trainees fall in the middle bands. There is near-absence of higher bands in the common training program, while it can be seen in the stream training. This could be attributed to the fact that the

trainees are new in the organization and are still 'finding their feet' during the common training program. During this period, trainees are exposed to a different learning paradigm, which emphasizes self-learning and problem solving. By the end of the common training program, the trainees are able to imbibe the new learning paradigm. Hence, they are able to do better in the stream training program. During feedback sessions, trainees place these two aspects as the best part of the training program.

Qualitative observations

With training and experience, almost all fresh graduates are able to attain the competency level required to be successful in industry. However, about 70% of the curriculum is generic and non-TCS specific. It is a well-known fact that only about 25% of the fresh technical graduates are employable. In this context, it is pointed out that even though the subjects of programming and software engineering are part of the curricula of many universities, not enough emphasis is given to these subjects. It is recommended that the learning pedagogy be modified to place more emphasis on self-learning and problem-solving. As the IT industry is maturing, the definition of an IT professional is changing. Increasingly, IT professionals are expected to possess domain skills in addition to basic IT skills.

Some of the other qualitative observations are :

- Fresh graduates come into industry with a mindset of finding short-cuts to pass tests. This results in undesirable learning patterns. This could be corrected by changing the mindset towards education in universities
- Fresh graduates lack a strong ethical foundation. Introduction of ethics as a subject in engineering education in universities needs serious consideration
- Fresh graduates tend to gravitate towards group thinking as opposed to individual opinions. Universities could look at interventions to promote thinking individuals
- Fresh graduates seem to lack appreciation for deep understanding of fundamental concepts. They often look at splitting hairs about whether their solution is 50 % correct or 60 % correct. The industry requires a solution which is 100% right the first time every time. This requires a mindset change and a change of the learning process.
- The majority of fresh graduates look to a teacher explaining concepts in simplified form as the only form of learning. They need to learn to become self-reliant.

5. Conclusion

The quality of fresh engineering graduates has been a key factor in the success of Indian enterprises in the global market. A large number of engineering colleges were set up in recent years. The number of engineering graduates joining Indian industries is on the rise. There is need for close interaction between Industry and academia to bridge the gap between the industry needs and the competency level of fresh graduates.

Appendix-1

Performance index (PI) is used to measure the performance of the trainees in both common training and stream training. It is calculated as follows:

Five performance ranges are defined as follows:

R1 → 0 to 39

R2 → 40 to 49

R3 → 50 to 59

R4 → 60 to 69

R5 → 70 to 100

If n_i is the number of participants who scored marks in the range Ri then the PI is calculated as

$$\mathbf{PI = \Sigma W_i n_i \quad for \ i = 1 \ to \ 5}$$

Where **W**=(0.0, 0.0, 0.2, 0.3, 0.5)

Appendix - 2

The following definitions are used to assign levels to the competency of the trainees in English oral and written communication.

Level 0

Limited vocabulary, heavy mother tongue influence, mistakes in grammar, syntax, tense, and spelling

Listener/reader has difficulty in understanding the communication

Level 1 :

Meaning of the communication is understandable, has basic knowledge of grammar but there are language errors,

Level 1 participant cannot sustain communication for a longer duration, first language interferes in stress and intonation.

Level 2 (desired level):

Can sustain long conversations, fairly good pronunciation, are aware of aspects that influence readability,

Can write Memos, Business Letters, Resumes, Emails, Minutes of the meeting etc as part of their professional or business communication process

Level 3 :

Fluent in speech with no grammatical errors, good vocabulary. Pronunciation is accurate. Can write technical documents in good English.

Level 4 (akin to that of a native speaker)

Speech is free of any first language intrusions.

Can identify and follow different types of accents and converse with any native speaker with ease. Has expert knowledge of business communication and technical documentation.

Re-Engineering Present-Day Competencies by Design And Development Change

Prof. Priyavrat Thareja*

Abstract

It may be reiterated that the consortium of competencies required by today's engineer has only widened and also the realization that more accent is laid on cultural strengths and attitudes; concurrently calls upon to increase the intellectual sharpness of product. Both aspects of lateral and vertical grooming of students in engineering and emotional intelligence (elevation) should be catered to in the new state of educational process. There is thus a need to reengineer our engineering educational schems such that the system is robust and potent.

The current requirement of educational product is in diversity @ core competence. The know-all requirement spells the unique learnability concurrently with handling of diverse set of tools failing which the industry or society is ready to count losses incurred due to lack of competency. Most of the infrastructure for development of such activities should be provided in the academic environment, at the behest of student for 24 X 7 X 365 access. The ability and wherewithal to a work enabling and the modus operandi to nurse synergizing of technology is mapped by a continual gap analysis. The deployment of 4 DM as a methodology to Design, Develop and Deploy is introduced in this paper.

Responsibility of A Bad Product

Instead of defining quality as a positive attribute of a product, Genichi Taguchi, the Quality guru defined it as the financial loss or cost to society caused by undesired variance in the shipped product, including costs such as warranty liability and lost customer goodwill. (Ashley 1992) He supported his Robust Design concept by concluding 'What ever losses get associated with a product after it is shipped out from the factory premises, the onus of responsibility rests with the manufacturer'. Same premise must hold true in the case of education sector too. Applying this premise to the educational sector the Taguchi's above statement can easily be deduced to imply: "All the incompetencies in the graduate engineer attributed, at least, to the educational process rests with us, the educators (Thareja, Mahapatra, Sharma 2007)".

Practically, even in industry no process has ever been perfected so as to be able to give a zero defect product (Thareja, 2006, Crosby, 1992). In that case, all the non-conformances or warranty claims may be attributed to the operator. Hence no organisation or operator may take on complete responsibility, as envisaged by Taguchi. The gap is however being narrowed thanks to TQM/six-sigma culture and so on (Thareja, 2007 a).

The stipulation that "All the incompetencies in a duly professionally deployed graduate engineer rests in the educational process" is indeed not to be taken without a bout of chillies by the academicians. It is despite the fact that there is a considerable awareness, deliberate customer pressures for Quality of graduates, thanks to a large disparation of compensation structure and pressure from the

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managements where the education has gone commercial. Yet no one would be willing to take on responsibility for risks associated because of the misdoings of a bad product.

The onus of responsibility for the bad product has however been debated extensively in the Quality discussions world over. Further-on, while there may be debates launched over the current lack of authority of the academe over their raw material, i.e. students, and because of the stance over the statutory demands, that the students cannot be resorted to physical punishments or psychoemotional assaults by their teachers, it cannot be ruled out that a tendency in students to take their teachers for a ride proliferates. This is unlike the manufacturing sector where the raw material/or product does not retaliate. In a scenario, when the Responsibility to maintain the Quality of the product rests with the operators, the teachers may be seen to be looking sideways to avert the question when it is directed over them. Their simple excuse is that the students are obliged to share the responsibility of being an operator of educational process. They are merely facilitators and resource-providers.

The Quality guru W Edward Deming attributed 85 % of organisational problems to that of management. Taguchi's too stipulated that 80 % of the problems could be mended at the design stage. Both of these deductions are governed by the Pareto's 80/20 rule. Applying the mandate that 80 % problems may be addressed simply by addressing design aspects of education or the organisational part (at the hands of managers of operators- both students and teachers in their assigned functions), it can be said the modus operandi to save on the academic process quality rests on the higher level processes, namely design and organisational brain.

Given that the design process is always complex and so is the educational process, their interactions are likely to further complexity more strongly. Thus, it will be extremely challenging to comply with the requirements of catering to a robust product. Taguchi was additionally wary of the people's cultural aberration towards conduct/assurance of work Quality. He argued that the producer of a bad quality product was worse than a thief (Taguchi,1995). It is because of the fact that the product essentially changes ownership when it is misappropriated by a thief, but when it is subjected to Quality negligence, the product undergoes a basic loss in terms of its economic value or quantitative drawability. In contravention to Steven Covey's win-win attribute, the former (thief's case) is a win-lose situation, and a bad quality case is a total 'lose-lose' situation. Since there is a plethora of literature which complains of the student dissatisfaction over large contexts, it may be argued that there is a considerable 'Taguchi loss' to the society because of the poor quality of engineering educational process. Who is responsible for this loss is again a part of vicious circle.

The 'Taguchi Loss' Function

The 'Taguchi loss' function spells that the Quality loss becomes the square of deviation from the stipulated target or objective of product realization. Taguchi loss function is schematically illustrated in Fig 1. The question is what is this 'Target; in education? Is it the competency staked by the student or desired by the employer? If these are at variance then what draws the precedence? That is, what target should be considered by the academe: the syllabi, mandated by the student as per contractual agreement between the student and institute duly agreed upon by both of them at the time of admission or the concurrent demand of industry (employer) or the student? This is again complex and Fuzzy, and needs to be resolved for a successful consummation of the process .

Four Key Research Areas (KRI's) emerge, which are explicated hereunder :

a) One solution to this problem of 'gap in education delivered and education desired' again is in conscious design of the inputs. The design process should be mature enough to include stipulated changes in the technical and social environment expected over the duration of course and/or the productive deployment of the engineer. Who takes charge of the design of such inputs, the industry or academe?

b) The second possible solution is in giving the teacher a free hand. If the teacher has to take on the responsibility for the 'Taguchi Loss', then why can't the teacher be authorized to do concurrent engineering to the syllabi, continually delve in designing the coveted inputs and giving befitting instructions to the class. But then the question of accountability arises if this freedom is given. And how many of the present-day teachers will be takers of this challenge? It will have weight especially looking into a perspective when the onus of responsibility of a Taguchi failure should fall upon the academe as stated in foregoing text.

c) The third option is in giving the student a prerogative to select his product. As the entire student is the primary beneficiary of this activity, carrying the product (gains) to his/her employer, the prime choice of his final deployment of product rests only on him/her. The industry is though a consumer and the ultimate beneficiary but industry allows the student to be appropriately compensated for his displayed Quality both in cash and kind. The extent of the compensation vis-à-vis his services can be circumstantial and typical, yet it has sufficient correlation with the productivity and suitability of the individual. If, as a result of re-engineering of the scheme of engineering education, the student is given the reigns to progress his/her process as per his/her diktats, then a mature student may deploy him(er)self much better for deriving potential gain in similar environments. It is because the student will be benefited in the same way as the IT (Information Technology) acronym 'what you see you get' (wysyg) read as 'what you desire (from the academe) you get' (wydyg). The paradigm is however suspected for its applicability, being subject to the availability of the typical instruction/competence of the instructor in desired specialization.

d) The fourth option is the domain in the current structure, when a student is left to his/her own decision making. The society is not yet ripe for this interface unless the students have been culturally oriented to take charge of their own development. Reportedly some schools in American districts have worked on a combined model of (b) and (d) where the teachers allowed the students to engineer their own developmental direction, yet the teachers focused their energies on intended outcomes and concurrently engineered processes and systems to meet desired goals.

The next onus in these KRI's is to research which model (out of these four, or many) options results in the lowest Taguchi Loss Function to our society. The situation is again severing in complexity day-by-day because the world is continually transforming into a global village, the change in proverbial 'Change' is unprecedented in its nature and amplitude, the half life of available technological developments is being shortened to about one year in certain areas, many new areas or star dot technologies, (to specify the gravity of variety of elements in the same class, say Bio-technology, Nano-

technology, etc) are making outreaches and steadily strengthening their applicability in technological infrastructure. The impact of this change in velocity is that many a times the teacher is left behind (except in his/her areas of academic interests/ Key Research Areas), and it remains worthwhile that the student is given the reigns to decide his/her own thrust direction.

Design of The Experimental Stage

The foregoing discussion attempted to surface following two Key Problem areas (KPA's):

(i) The challenge on the academic process is grave. If they must conform to requisites of Robust Design and attempt to reduce the Taguchi's loss then the current process is perhaps not capable. One proof of this 'lack of process capability' is in the indifference of the academe to the student/ societal educational needs. Since the variation in popular quote — what does not get measured is not done — is concurred from this state of academe's indifference to student satisfaction challenges, the conclusion is fair.

(ii) The solution is in improving the process capability of our educational processes and Taguchi's clue to the improvement is to attempt a revival from the First principle (Thareja, 2007b). That is design. The whole process must be reengineered with a new paradigm based on the holistic student satisfaction + employer satisfaction model.

(iii) The contemplations of Technological Change and consequential increase in Taguchi Loss with time, because of such changes, call for the imperative solution to hand over the reigns of day-2-day education to the principal operators of education, i.e. students. This is the third option at part (c) above, and must be requisitely modeled to improve the engineering education paradigm as a part of the endeavour to reengineer our education. This is in concurrence with the student satisfaction imperative as deduced above.

(iv) The economic theory precludes predicting a focus on that which is measured, potentially at the expense of that which is important. However, in sectors characterised by incomplete measurements, obsessed by multiple stakeholders and containing workers with diverse objectives, the measurements become quite oblique.

The problem in attempting implementation of a solution to these two problems (KPA's) stated above is qualified as under :

- If the students are handed over the reigns of their own academic process, will they respond to exacting requirements of a holistic Disciplined Decisive Development? Such a development must undertake itself in a disciplined, ethical, and Quality environment, and does the society have the wherewithal to provide an environment conducive to the required self Discipline?
- The process of Disciplined Decisive Development (3D) calls for the competencies to be conclusive and proficient in settling an issue to the most socio-beneficiary option. Such a decision-making competency calls for a big maturity – both technical and conforming to SHEQPC (Safety, Health, Environment, Quality, Productivity, and Cost) requirements.
- A Disciplined Decisive Development (3D), therefore, requires a sea-change in the current engineering education system where the environment should equally contribute in the 3D

process, in contravention to the defines of system wherein the environment is not considered as an active player, as considered in the Design of Experiments (DOE) domain.

- Given that performance indicators do affect behaviour, it is important to minimise unintended consequences. Wilson, Croxson and Atkinson suggest the use of specifically designed value-added indicators of student performance (Aug 2004).

The stage for Design of Experimental-stage is, therefore, set. Our product needs to be holistically competent in terms of the decisions conforming to SHEQPC imperatives and employer satisfaction, and in turn it calls for a holistic development of the individual in disciplined environments which promotes self-discipline and high defend of ethics ( ).

Defines of this Experimental-stage

A stage is understood as an environment which allows the product realization to happen. The correctness of this deduction of stage as 'environment' may be evaluated considering the domain prescribed for stage as in exhibit I, as defined in oxford dictionary [1], including its suffixes. The environment may be physically improved, logistically made influencing, and/or conceptually controlled the scene of action. Someone can (stage) mange the show in the institute and deceive (or engineer) the proceeds in a given direction/objective. The stage can be mobile (point of activity is not local) or centred. Performers are subject to the fear because they are governed by society/observers, and to that extent, their whispers are subject to a constant evaluation. In short, the stage may be a centre of divergent activity and can be engineered for developing an institute culture which distinguishes it as a brand or simply a battleground of trifle issues.

exhibit I : Stage and its suffixes as defined in oxford dictionary[1]

Stage —n. 1 point or period in a process or development. 2 a raised platform, esp. for performing plays etc. on. b (prec. by the) theatrical profession, drama. c scene of action. 3 a regular stopping-place on a route. b distance between two of these. 4 Astronaut. section of a rocket with a separate engine. —v. (-ging) 1 present (a play etc.) on stage. 2 arrange, organize (staged a demonstration). [French estage, ultimately from Latin sto stand]

stagecoach n. hist. large closed horse-drawn coach running on a regular route by stages.

stagecraft n. theatrical skill or experience.

stage direction n. instruction in a play as to actors' movements, sound effects, etc.

stage fright n. performer's fear of an audience.

stage-hand n. person moving stage scenery etc.

stage-manage v. 1 be the stage-manager of. 2 arrange and control for effect.

stage-manager n. person responsible for lighting and mechanical arrangements etc. on stage.

stage-struck adj. obsessed with becoming an actor.

stage whisper n. 1 an aside. 2 loud whisper meant to be overheard.

[1] Pocket oxford dictionary (1994) University Press, Walton Street, oxford (March)

Once the institute is 'stage-managed' with a typical style, a few following things in the context of setting within the educational process emerge:

1. The educational process is managed not merely in the classroom but through a total life style activity. In fact, since the complete enact of human life is education, and so is a stage, duly dramatized and recorded as in the movie 'Anand': "Babu Moshaye, Hum sub is rangmunch ki kathputliya hai". (Gentleman, we all are the touts of this play-stage (house)) The environment in the institute has, therefore, a large effect on the student. The institute is akin to a stage where the student is enacting his/her activity, and taking home (to his/her customer) the holistic receipts from the Institution. It includes the material gains, conceptual and physical transformations induced in him/her, and carries even the brand name. Technically the student acquires the life's SEAT (Skill, Education, Attitude, and Training) of success, which SETs in the attitude for Life Long Learning, essential for acquiring necessary and local competencies concurrently at work (Thareja, 2008a).

2. The environment in the Educational Institution determines the brand students carry forward (Thareja, 2007c). If the students have to flag engineering competencies forward as a take-along, they have a challenge to gain the experience and technically contribute to the engineering institute. It can be affected in maintenance, resource-building, experimentation, hobbies club and even for industrial/societal service. The students should enact through maintenance, assistance and amateur to semi to fully-skilled assistances. Contribution to consultancy and 'earn while you learn' schemes tend to induce motivation. Ensuring sale-ability of experimental products (jobs produced in the workshop) can help in resource conservation towards a superior natural environment, material (and financial) resource conservation for the institute, better organisation of consumable training stores and self-sustaining (remunerative) Material resource planning. It should facilitate product design ability as the challenges are accepted to produce bigger and costlier outcomes (products) as a result of workshop experiments. Increase of consequential challenge and reduction of resource-allocation constraints and inputs, both are a prima facie Motivation to instructors and students. The model has been put into operation by PSG Institute of Technology.

3. The environment of the Educational Institution creates a learning rhythm – in the center stage-within the flexibility of a 24 X 7 X 365, fully networked and integrated campus concurrently with 24 hour – online- learning support and availability of self assessment tools (Thareja, Mahapatra, Sharma 2006). This should help average learners with zeal to display above-average performance, thanks to a learning facilitating environment (Thareja, 2005).

4. The environment in the educational institute is controlled, as if by a conductor of an orchestra, to orchestrate Commitment, Culture, Communication & Concern on which the pillars of educational process are built (Thareja, 2008b)

Who Controls The Environment

The journey from childhood to that of being a creator of material goods, infrastructure and/or functional products etc, is an arduous one. The system of development traversed in this journey,

essentially incorporates a process called engineering education, which must enable him "to make a reality of the potential value of science by translating scientific knowledge into tools, resources, energy and labour to bring them into the service of man…" states Sir Eric Ashby. "To make contributions of this kind, the engineer requires the imagination to visualize the needs of society and to appreciate what is possible as well as the technological and broad social understanding to bring his vision to reality."

Fig 1 schematically illustrates the paradox in developing competencies required by the consumers of educational product (industry or individuals) vis-à-vis of the engineering student himself, which itself are growing Thanks to the booming of innovations and consequent launching of newer products each day. The consequential change in expected Process aspirations vis-à-vis designed outcomes increases the dissatisfaction gap between the two. The actual consumer requirements are possibly further off the target, being distant and because of inadequacy of communication. The total system is concurrently under the influence of Culture of Learner (or Operators) which impacts objective realization and Work Enabling requirements

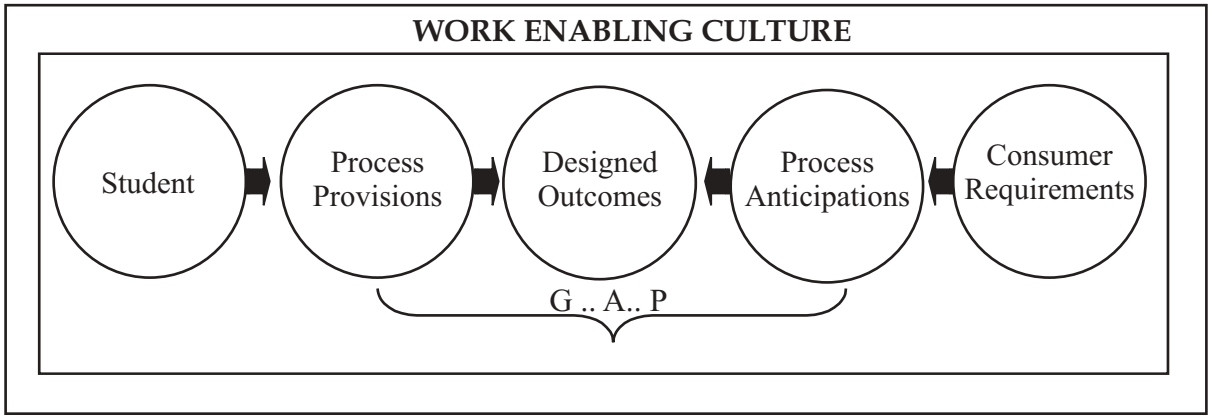

Fig 1. : *The Schematic Process aspirations in designed outcomes and actual consumer requirements, under the influence of Work Enabling requirements impacting Culture of Learner (Operator)*

For SEATing product realizations following attributes should be catered to:

(i) Cater to meet individual's requirements concurrently adjusted w.r.t consumer's stipulations, and not to pre-designed metaphors of conventional (industrial) Quality.

(ii) Improve the quality of work enabling culture/attitude,

(iii) Synergy of education (core knowledge) with Technology facilitated by use of Tools, and

(iv) Improvement of Skills and General competencies, including that of meeting aspirations and Benchmark organizations

Managing Design To Deployment For A Robust Product

The solution is in maintaining the Quality of environment as proposed in the aforesaid discussion, implemented by the 'Defining' of the gap (Analysing previously consummated supply and need), Design the path of corrections for gaps/deviations, Develop solutions, Deploy the solution on the process, and Manage learning concurrently with the streamlining of educational stimuli. The process

stipulates '4DM' as acronym, and has controls exercisable in a variety of processes, including education. The process of continuously controlling Design and Development (D&D) Change requirements, necessitates that D&D programs are duly specified, undergo standardization and favour due specialization, to make them fit for deployment. It is seen that most of the educational processes tend to insulate them from the clause 7.3 of ISO 9001:2000 Quality Management System certification, when they present them for accreditation. The onus is, therefore, on the managements (Principals/ Directors etc) to set in a holistic Quality Management system, which is capable of automatic renewal. To meet such contingencies and challenges induced by Change, the current engineering education system deserves constant rejuvenation.

'Reengineering' conceptually empowers new creativity in problem solving using radical rethinking to meet stated objectives optimizing current technologies. While the engineering graduates accurately foresee compelling requirements of near future and determine requisites to realize them, reengineering@D&D presents itself as the preamble to conform the students to forecasted requirements. The specifics of educational process for a successful product realization are concurrently deployed and managed in the Dashboard style for a new design and developed Change within the system. Thus, there is a renewed need of ascertaining mandates of environment which nurse and control excellence in the context of Intrapreneurial attitudes commitment and culture.

To conclude if the product (from education sector) is required to emerge as robust, the academic process must be strengthened for its (design) abilities congruently with the premise that responsibility for the same stays with the operators (manufacturer); a combine of educators and the students as bundled commune of an unseparable learners; in the system which exists in the motivational environment designed to breed excellence.

At Punjab Engineering College we define this environment with a Punchline: Explore-Innovate-Excel.

Conclusions

1. The current system of our Engineering Education is incompetent on many accounts. The largest and the most dominant one is the that the inputs are not aligned with the outcomes. There is an urgent need to reengineer it. The strategy must be carefully regressed.
2. It follows from above conclusion that today there is a need to develop holistic engineers who are masters of all trades. The Institute may provide due resources who work with students in a co-operative set up and design and develop the stimuli at the premise of just- in- time basis.
3. The infrastructure provided should facilitate development of such activities and predesigned integrally in the academic environment. It should be at the behest of student for 24 X 7 X 365 access.
4. The wherewithal for Learning groups be aligned to holistic growth enabling culture and the modus operandi for the same may be concurrently designed.
5. The Design system is based upon 4 DM methodology voiced in the paper, and caters to the objective of minimizing Taguchi Loss function

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Re-engineering Through Nanotechnology

Prof. Javed Husain*

The history of technology has seen a number of episodes of re-engineering. One such transformation took place in the late 19th century when, because of the great strides in electrical applications, engineering became much more than mere mechanical and civil engineering and added electrical engineering to its corpus of knowledge. Similarly, the emergence of electronics in the 20th century was another great example of re-engineering. This was followed by computers and information technology revolutions.

Now what next? Are we going to see more waves of re-engineering? At least one such wave has already started to hit the engineering shores and promises to have consequences for all branches of engineering. This is nanotechnology.

Nanotechnology is based on being able to manipulate matter at the level of particle sizes of less than 100 nm and consisting of a few dozen atoms or small molecules. At this scale the surface properties begin to play a much more important role than with bigger size samples.

Nanotechnology may be expected to provide the future building blocks of all technology. Traditional manufacturing has been based on a top-down approach. This works by starting from bulk raw material and generates the finished products through various processes such as cutting, milling and shaping. Such an approach leads to wastage of both the raw materials as well as energy. It also gives rise to atomic level defects in the finished product.

The advent of nanotechnology can lead to a major re-engineering paradigm shift. The new technology involves a bottom-up approach which is ubiquitously present in nature, including plants and animals. It involves manipulation at the molecular or nanoparticle level. The finished product based on this approach is of far superior quality and there is minimum wastage of the raw materials as well as energy.

Nanotechnology business has now taken off in some of the developed countries. World-wide, the amount of money spent by the private sector on nanotechnology R&D has begun to exceed that put in by governments and is likely to become several times within the next few years. This is a very strong indicator of the fact that the private business sector has become serious about nanotechnology.

At the moment, the supply of nanotechnology related instrumentation and the supply of all kinds of nanomaterials have become stable business areas abroad. The incorporation of nanomaterials have given rise to dozens of new products (see, for example, http://www.nanoshop.com). These range from paints to textiles to packaging materials to cosmetics to foods. More products are likely to be introduced in the coming months and years.

The time of nanotechnology has also arrived in India. The governments and the institutions of higher learning have been quick at adapting themselves to nanotechnology. However, the response of the

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business community in India has been less than desired. Perhaps, the glamour of the information technology revolution has over-ridden the mental frame-work of our private sector. The general business bodies in India are trying to play their role but a separate nanotechnology business organisation does not exist. An early attempt in this direction is the Delhi Nanotechnology Business Group (http://nanotech.meetup.com/62)

Nevertheless, we are beginning to see the emergence of a few nanotechnology-based products in Indian markets.

One of the most important nanotechnology businesses, which are taking off in India in the first wave, is nano-instrumentation. The country needs suppliers of instruments to the dozens of colleges and universities which have opened up nanotechnology courses.

Yet another area of nanotechnology business opportunity in India is the manufacture and supply of nanomaterials. These are expected to be the building blocks of the future. The supply line of these materials must first mature before any significant industrial applications can be developed.

Nanotechnology consultancy is also an early area ready for grabbing. One of the most lucrative jobs of consultants would be the production of business reports relative to the establishment of different types of nanotechnology businesses in various parts of India.

Somewhat related to consultancy is the area of re-engineering through nanotechnology short courses and training. Whereas a good number of nanotechnology degree programmes are running in India and also a sizable number of conferences are being organized, short courses in nanotechnology have so far not taken off in a significant way. Some early effort in this direction has been made by the Nano Science and Technology Consortium (http://www.nanostc.in).

The demand for re-training and short courses can be expected to take off only when nano-industry takes off in India. As long as the critical mass for nanotechnology short courses takes time to develop, it would be wise for different organizations to introduce "emergent technologies" courses which would consist almost fifty percent of nanotechnology but would also cover some other areas as well. Our governments as well as the corporate sector need to get their engineers retrained from time to time in these emergent technologies courses. Of course, our engineering colleges and polytechnics need to take the initiative in developing the needed courses. The Indian Society for Training and Development can also provide leadership in this area.

Nanotechnology is amply suited for the small business players. This is because many of the nanotechnology products that have become available recently are of a "passive" nature in the sense that they do not require after-sales service. On the other hand, businesses which require after-sales service, can only be set up by big companies.

The health implications of nanotechnology, in case there are any negative ones, are not yet fully understood. Research is badly needed. Right now there is even no labeling requirement for nanomaterials used in various products. The European Union have done well by announcing that in

Engineering Education & Profession in India-High Time to Re-engineer

*L. Pugazhenthy**

Evolution of Engineering

Engineering seems to be oldest skill or passion mankind had from time immemorial. It should be interesting to understand the true meaning of engineering. Different dictionaries define engineering as :

"..... using the laws of nature to create and refine....."

"..... the science by which the properties of nature are made useful to humans....."

".....the art of directing the great sources of power in nature for the use and the convenience of humans....."

The commonality in all the three definitions is nature; the ancient man created fire (energy) by rubbing stones through friction, while the modern man produces energy from a running stream of water. Our ancestors built tunnels, irrigation channels, and drainage systems etc, as public amenities. It is amazing how our forefathers would have handled the construction materials and built the well known monuments like pyramid, pisa tower, taj mahal, iron pillar etc. which are strong and stable even today. The industrial revolution saw the emergence of many engineering devices like the simple pulley, moving wheels, steam engines, electric bulbs, telephones etc. which were the pioneers of many sophisticated and modern gadgets that we use so commonly.

In its modern form, engineering involves men, money, materials, machines and energy. Engineering is different from science because it is totally application-oriented, applying

The scientific theories for useful and economical ends/applications. Therefore engineering requires the creative imagination to innovate useful applications of natural phenomena. Creativity or innovation is the hallmark of engineering. That is why we see a young, creative child desiring to become- when grown- a jet pilot, an engine driver, an astronaut etc,-all linked with gadgets developed and produced by engineers. Engineering is dissatisfied with the present methods and equipment; it always seeks newer, cheaper, better means of using natural sources of energy and materials to improve the standards of living.

Traditionally there were two divisions or disciplines- military engineering and civil engineering. As knowledge of natural phenomena grow and the potential civil applications became more complex, the civil engineering discipline tended to become more specialized. Gradually civil engineering came to be concerned with static structures such as dams, bridges, buildings etc, whereas mechanical engineering focused on dynamic structures such as machinery, automobiles, engines etc. From the practical applications of electricity and chemistry, disciplines like electrical engineering and chemical engineering emerged respectively. Mining engineering became a discipline for exploitation of natural mineral resources while metallurgical engineering involved extraction and refinement of metals from the ore bodies. Over a period of time, this splintering process continued and we began to see structural

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engineers, bridge engineers, highway engineers, public health engineers, electronic engineers, communication engineers, aeronautical engineers, petroleum engineers, marine engineers so on and so forth.

Engineering- Current Scenario

Engineering has thus become multi-disciplined and multidirectional, the same way doctors and lawyers became micro-specialists. The changing situational requirements also demanded expertise in the form of specialists.

What has happened gradually in engineering is in-depth specialization, which is justifiable considering the demand-supply factors. The specialization in various disciplines of engineering also met the needs in infrastructure development, industry research and teaching. These engineers could eventually set up modern manufacturing plants, research bodies, educational institutions etc, besides creating world class facilities in highways, airports, power, telecom, IT parks, retail malls etc, in many developing and newly industrializing economies. While these developments are indeed encouraging, we must also see the flip side of the engineering community.

Engineers continued to focus and specialize in their chosen areas of specialization only, keeping their eyes completely closed in other areas concerning the society or the organization. Engineers remained, by and large, insulated from the modern and emerging techniques in HR development, financial management, business management, marketing and sales management, Engineers were happy and complacent meeting the production or quality targets. Society looked at engineers more as managers of machines; many engineers lacked the basic knowledge in finances and a large number could not even read and interpret the balance sheets of a companies. Above all engineers lacked appreciating the importance of behavioural sciences like psychology, motivation, incentivization, group dynamics etc. For all these deficiencies, we should not rush to blame the engineering community. The root cause is the educational and merit evaluation systems that we have inherited, which we had not revalidated with the changing needs of the society or the organizations.

Engineering-Future Scenario

India, at present, is fast emerging as a knowledge economy. Many blue-chip companies have set up manufacturing bases, research and development centres, design centres in India because of the vast engineering and software skills available in the country. India is expected to become an export hub for many companies around the world. Our engineers should have the power and vision to understand as well as comprehend the existing and the power to make exciting new beginnings for discovering the unknown-to leverage innovation, research, optimization, breakthrough technologies and developments to sustain the whirlwind pace at which the world is surging ahead in the knowledge sector. Besides the nuclear advantages, India's spacecraft reaching the moon through "Chandrayan", has already put the country in the super league. All these mean that Indian engineers will have to be multi-faceted, global engineers with a high passion for innovation. It is the innovative spirit of our engineers as well as the scientists that is going to take India several miles ahead of other countries in the race for global leadership. That is where our homework also begins to critically look at the current educational and training systems so as to bring about radical changes in the shortest time. It is also here that the process of re-engineering of our engineering education and profession should begin.

Reengineering of engineers

Current situations demand engineers to be, besides being practical engineers, conversant with management of men, money as well as materials and be effective in communication and interpersonal skills. The process of reengineering of engineers could include, among others, the following multi-pronged actions :

- talent search at the school level

  (whereby boys and girls with an engineering bent of mind are identified and selected for engineering education. At the school level, in addition to the arts and science streams, there should be an engineering stream.)

- skill development at ITIs / polytechnics

  (students with middle level school and/or final level are trained as technicians, operators etc.)

- engineering education at IITs/ Engg Colleges

  (students with school final be given a sandwiched, intensive industry-institution training and education)

- a high involvement by the industry in engg-education

  (industry, in their own interest, should be made to support nearby colleges through scholarships, stipends etc, for the students as well as in-plant training)

- involvement of industry in curriculum development

  (the engineering industry, management institutes and research/technical institutions should be actively involved in development of a broader curriculum and periodic revision/updation every ten years)

- the academia-industry exchange

  (industry executives should be persuaded to take classes and the academia should be given consultancy assignments/opportunities to spend a specified time in the industry)

- spot the cream in the engg colleges

  (engg college students with a high flair for research, design, development, teaching etc, should be spotted for specialized training as well as higher education and given appropriate jobs to shape them)

- a check on the private engineering colleges

  (all the engg colleges which have come up in recent years should be audited for the facilities, faculty, quality of students passed etc.)

Conclusion

The above suggestions are some action points which should be taken up immediately on a priority basis at the national level. There may be many more practical suggestions from others which should also be considered and integrated. Bare or minimal involvement of government in curriculum development and technical education is desirable.

Pubic-Private Partnerships (PPP) in engineering education should be encouraged to the maximum extent possible.

Inadequate availability of Civil Engineering Manpower – A Major Road Block in Quality & Construction Economics of Projects - Solutions & Remedies

*K. K. Agrawal**

Abstract

Short availability of adequately qualified and trained Civil Engineering manpower is a major road-block in the pace of development in the Real Estate and Construction Industry at large. This issue has not been addressed so far in the industry though the necessity is being felt greatly.

This is greatly affecting the product quality. This is also causing an unwarranted increase in project costs in design process and construction, both.

The situation is going to worsen in time to come as the pace of construction activity, picked up fast and high in the last few years, will continue to grow for at least a quarter of a century more.

The number of Civil Engineering graduates passing out annually is so low that it covers up only a small fraction of the market requirement. The quality of product from many-an-institution is far below desirable standards.

The diploma holders in Civil Engineering, though are in short supply in present times, are still not in reckoning as a force to come to the rescue of the situation, with short term skill up-gradation programs, later here suggested as part of short term solution.

The existing manpower needs to be trained for the new technology, for their optimum utilization and continuity for application of the changes in technology.

Hence, "Project Economics & Sustainability" and "Quality & Competitiveness" are the biggest casualty. The "Capacity Building" will suffer causing a great concern specially when "Globalization" is already not only on the doorsteps, is rather an in-thing.

This write-up presents the problems in its gravity and proposes solutions – both, long term as well as short term.

Prelude

The **Civil Engineering construction activity** in India has grown, in the last few years, in **explosive proportions** in the areas of Buildings – Residentia/Commercial/Industrial - and Civil Engineering Infrastructure – Roads, Highways, Fly-overs and Bridges/Energy & Power Generation/Tourism & Hospitality, Etc. The pace **will not slow down for the next 25 years**.

Planning and designing is getting more **complex and encompassing** with its new dimensions. The old traditional methods of construction are fast being replaced by **mechanization and automation** but much more is yet to come.

The need for achieving **project's economic sustainability** has thrown new **challenges** on the need of **high quality** and **economy of cost and time of project delivery**. **Competitiveness** is the **keyword** in all aspects of **project planning, designing and construction**.

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Adequately qualified, trained and sufficient **manpower availability** is **imperative** to productivity and to keep pace with the need for **healthy competitiveness** and **need for Client care**.

There is an **acute shortage** of **qualified and adequately trained Civil Engineering manpower** in the entire country; the demand has gone already multi-fold and will grow even further in the years to come. The situation may explode, if not properly and timely tackled on a war footing basis.

The fresh Civil Engineering graduates of **reasonable standards**, too, are **not available**. The quality of the available Civil Engineers is far from meeting even the minimum requirements.

More of **mechanization and automation** in construction, though not catching up at the pace that it should, **may only slightly offset** the manpower requirements. However, the wide gap between demand and availability/need and availability does remain, in all areas of designing, project planning and management.

The **non availability** of qualified and properly trained manpower will cause **inadequate quality** of the product and **very high costs** besides having to be forced upon a substandard product on account of **haphazard and sparsely attended project planning, designing and construction management**.

This is going to be highly **counter-productive** to the **project sustainability** and will leave us far behind in global competitiveness, unless tackled and remedied very fast and on the war-footing. The ill effect is not so acutely felt now in view of middle and senior level who were earlier languishing in stagnancy, being still available. The situation is going to be beyond control once this level tapers off in due course.

Suggested Remedies & Solutions

Solutions are suggested, as **short term** as well as **long-term** measures, for **express/concerted action plan** and immediate implementation.

a) Short term Measures :

i) **Qualification and skill upgradtion of Diploma holders** (and poorly qualified graduates) in Civil Engineering through specially **designed and structured training capsules** separately in the areas of a) **Structural designing** and b) **Construction Management and supervision** providing for application variability in different fields. This will partly **fill the gap** caused by shortage of Graduate Civil Engineers.

ii) Another program for **qualification and skill upgradtion of Advanced level** to the available **graduate Engineers** in a) **Advanced Structural Designing** and b) **Advanced Project Planning and Construction Management** . This will enable developing Designers and Construction Managers and will fill the gap caused by virtual non-availability of Post-graduates in Civil Engineering.

iii) The Engineers and Managers working in the industry with Consultants, Contractors and User organizations should be periodically subject to new professional developments through **in-service skill up-gradation short courses/workshops**, as regular measure of professional updating. This aspect of human resource management has to be brought home to the user

organizations–Construction companies, Real Estate Developers, Design Consultants and Construction Management Consultants.

iv) The **issues to be addressed** for **all** the above mentioned **measures** are :

- **quality and contents of the up-gradation programs** to be **state-of-the art** updated and be industry specific and application-oriented;
- **extensive training of the trainers/teachers** of these programs
- **vocationalisation of the training and teaching** with **high assimilation** and **absorption** levels
- organizing **special training** of the **Academia faculty** to meet the standards and requirements of teaching to be of optimum use to **direct application to the industry**
- using the **trainers from the industry** and causing **interaction** and even **exchange** between **academia and industry professionals**.

b) Long-term Measures :

There is a serious **necessity** for bringing about **reforms in Civil Engineering education** in the country at the graduate, post-graduate and research levels, to make the **education state-of-the art, useful, objective, "Industry-responsive", and "market-need-specific"** suitable as **"Application-Oriented"**.

The **contents and syllabi** need immediate **modification** as part of **"course-correction"**, specially at **graduate level**, still remaining in **very old and traditional frame** and proving to be **insufficient** to cater to the **need** of the modern day technology required by Civil engineering projects **in terms of materials, design, construction methods and management and, realty maintenance**.

The suggested reforms are in **direct response** to and guided by the **industry requirements** of date and of the immediate as well as distant future in order to make the **teaching and contents of knowledge transfer** of the **Civil Engineering** as **objective, responsive, directly application-oriented and helpful in improving on quality and cost effectiveness** of the Civil Engineering projects.

The reforms proposal, hence, needs to be acted upon actively and on a fast track as action to bring it to implementation level may take time; and after implementation of the reforms in education, the results take as much as 5 years before fructifying and results start showing up on the ground.

Suggested Reform Proposals in respect of **Degree** Programs :

- The size of projects, their complexity, need for cost-effectiveness in structural designing, the updated materials technology and modern and mechanised construction techniques, make the available level of course contents in existing degree programs appear as too general and grossly insufficient. These are not able to cater to the requirements of present-day level of technology.
- The existing Civil Engineering under-graduate degree courses are of general subjects covered in 8 semesters in 4 years' duration.

- More contents and specific discipline-wise industry-specific specializations need to be included in the degree course syllabi and duration of the degree program needs to be increased. Splitting up of the degree courses suiting the discipline-wise course contents is called for.
- The present degree programs of 8 semesters need to be changed to separate Honours Degree programs of 9 semesters in various different specialized and application courses covering updated and modified courses conforming to newer technology in various application areas. The first 5 to 6 semesters remaining common to some or all and the last 4 to 3 semesters devoted to the respective specialization
- The duration should include the practical training and compulsory exposition to at least two projects related to the relevant specialization, one each in last 2 semesters of the honours degree course.
- There will have to be sufficient choice in the list of elective courses available to choose various sub-specializations in different programs.
- The standard of the courses, in theory content, will be higher than that of the present under-graduate teaching programs and slightly lower than but touching the boundary of the post-graduation.
- However, the orientation, besides coverage of adequate and comprehensive theory, will be practical, vocational, with sufficient direct application practice and market-need/industry-specific, that is, of direct professional application rather than being general and theoretical alone.
- The areas of **Honours courses** will be in the streams identified below.

  a) Structural Engineering ***(Bachelor of Structural Engineering)***
     - Specialization in Building Structures
     - Specialization in Bridges & Grade Separators

  b) Geo-technical Engineering & Foundations ***(Bachelor of Soil Mechanics & Foundation Engineering)***

  c) Transportation Planning & Engineering ***(Bachelor of Transport Engineering)***
     - Specialization in Roads & Highways
     - Specialization in Railways & local Rail Transit Systems
     - Specialization in Ports, Harbours & Off-shore Structures
     - Specialization in Airports & Civil Aviation Infrastructure

  d) Construction Management & Maintenance ***(Bachelor of Construction Management)***
     - Specialization in general Buildings
     - Specialization in Roads & Highways
     - Specialization in Industrial Projects

e) Public Health Engineering & Waste Management ***(Bachelor of Public Health Engineering)***

f) Irrigation Engineering & Hydrology ***(Bachelor of Irrigation Engineering)***

g) Rural Infrastructure Engineering ***(Bachelor of Rural Engineering)***

- The number of seats in each of these courses has to be optimally high, at least for a few years may be a decade, depending on the infrastructure capability and faculty availability of the Institutions.
- All this will cause huge augmentation of the infrastructure/resources in each academic institution. The financial support has to come from the Industry out of the savings expected to be generated in the process. The protocols and procedures have to be set up by activating the Administrative organizations like AICTE and Min. of HRD at the center and similar action in respect of the State controlled organizations..
- Augmentation of **Part-time Degree Programs** :
- The part time degree programs are offered by some institutions to Diploma holders. These programs should be made more popular with certain incentives to the students as well as to the Institutions.
- The course contents and syllabi should be upgraded to include more relevant subjects and the degree courses need to be vocational and specialized.
- Such courses should be made popular in the absorbing industry who can provide support to part-time degree courses by sponsoring people working with them.

Suggested Reform Proposals in respect of **Post-Graduate Degree** & **Research** Programs :

- The Post-graduate program contents can follow the degree courses mainly for higher specializations and advanced applications as well as preparatory to suit the research applications; but it is also suggested that PG courses' admissions should have a mandatory pre-requisite of 1 to 2 years of practical service experience as compulsory for seeking admission to PG programs. The contents and direction of the PG courses also need re-orientation and reforms so as to make them industry specific or research-oriented.
- It is just mentioned that level and quality of research, specially in Civil Engineering applications, needs to be upgraded to higher standards, to be objective and to be of linkages and application to industry. The research should be on current and contemporary topics facing the Civil Engineering requirements on materials, designing, innovations, etc. leading to cost effectiveness. In fact, the present trend of research, having come to be lacking in excellence, needs a thorough course-correction without delay.
- The faculty for the purpose will need to be given special training and orientation in teaching methods of not only traditional theoretical treatise of various subjects but also of practical subjects to suit the industry requirement. This will be done by putting them to some essential courses/workshops conducted by industry professionals for fast track qualification achievements.

- We also suggest that the Engineering Institutions should seek Industry professionals also as Faculty for certain courses which relate to mostly practical working. This can be done by introducing Industry-Academia Interaction and Faculty/professionals exchange programs between Industry and Engineering Education Institutions.
- The help can be sought for from highly qualified persons from Govt. sector, Public sector, private Corporate sector and certain proven individuals from amongst practicing professionals.
- These types of interactions will partly solve the problem of shortage of trained faculty as well as give a platform for understanding the Industry requirements to reinforce the courses and its contents.
- Such interactions will also help understanding, synthesizing and compiling of the Industry and market requirements, from time to time, to enable the course contents to be dynamically upgraded as a continuing exercise. A mechanism will need to be developed for this type of course correction in the syllabi of the honours degree courses.

Summary

- There is gross shortage of availability of qualified Civil Engineering graduates for the volume of construction activity in the market. This is causing the set-back to the Project Sustainability and Capacity Building putting the country at disadvantage in the Global competitive situation.
- The shortage is in all the areas, viz., "Project Planning", "Designing" and "Construction Management".
- Similarly, for specialized structural designing, there is far worse situation of availability of qualified postgraduates in Structural Engineering.
- "Long term" and "Short term" solutions to meet with the requirements are proposed for immediate implementation.
- **Long-term proposals** are meant for the **Engineering institutions like IIT's and NIT's** to start with the least wastage of time in processing approvals, specialized courses of **BE/BTech in "Structural Engineering", "Construction Management",** and the like in other specializations in Infrastructure and Public Health related Environmental Engineering fields.
- This can be done by introducing special subjects with required contents relating to the speciality of the course in the last 2 to 3 semesters of the degree program, of level higher than graduation and lower than post-graduation in respective areas. Thus, the present ongoing batches in Civil Engineering program can start producing the results within 1-1/2 years of decision making at appropriate levels, in the Engineering institutions.
- The **Short-Term proposals** can be undertaken by professional organizations like **Engineering Council of India**, **Institution of Engineers (I)**, **Consulting Development Council**, **Consulting Engineers Association of India,** in addition to the prime Engineering Institutions like **IITs and NITs** with **close co-operational interaction** with professional organizations and the professional private and Govt. sectors.

- **The urgency and necessity needs to be genuinely felt and appreciated by all transcending the professional egos, complexes, differences and perceptional rivalries/disparities.**
- **Continuing Education System** needs to be understood as the **necessity for growth** of the Professionals.
- To meet with the present and immediate demand, it is proposed that available qualified and eligible diploma-holders be given special part-time training programs, on part-time basis, in the areas of "Structural Designing" and "Construction Management" of duration of about 4 to 5 months with extensive subjects' coverage and high class teaching to prepare professionals ready for use by design offices and on construction sites.
- Quality, however, needs to be ensured in order to uphold high standards of teaching and training with a practical and vocational orientation. The outline syllabus is also suggested in this paper .
- This type of program can be started by existing Engineering colleges, authorised Training establishments in Govt./private sector and certain qualified private organizations.
- Similarly, a post-graduate level program in advanced Structural Analysis and Designing has been suggested for graduates to be trained, almost at par with PG level, with a 4 months of extensive training program with course coverage such that the program makes these persons ready for use in the Design offices. These may prove even better than the fresh ME/MTech pass out in view of the practical and more advanced syllabus proposed here-in-above.
- **We have already conducted certain of these programs in central Govt. as well as in private sector and are very confident of its meeting the market requirements.**
- However, selection of qualified and adequately experienced faculty and strictness on quality control is important.
- The available organizations should come forward to carry out these programs with a definite goals and objectives.
- **Industry participation** has to be pro-active to see that the above mentioned proposals are given due consideration by all concerned.
- We feel that professional bodies like **Engineering Council of India**, **Institution of Engineers (I)**, **Consulting Development Council**, **Consulting Engineers Association of India**, and the like, **must get seized of the matter** and come forward for playing necessary role shedding out the hesitations and inhibitions.
- **Industry's cooperation**, in the matter, **with the Academia** has to be ensured and organised in terms of financial assistance and funding in the huge efforts for augmenting their infrastructure for implementing the reforms as well as increasing the seats in various courses of Civil Engineering Stream.
- This money can easily be spared in view of the expected quality improvement and anticipated savings in the project costs.

- Industry should also come forward for Academia and Industry cooperation in the field of teaching, revision of syllabi, exchange of faculty, technology transfer etc.
- The efforts of ECI in conducting the present conference is the 1st step in the direction which needs to be extended on war-footing by all concerned, as suggested in this presentation.

Samples of Course Development for Certain Continuing Education Programs

We present herewith sample syllabi of certain programs already developed as part of Continuing Education systems as aforesaid in this presentation. These are contained at Annexures 1 and 2 for the Diploma holders in Civil Engineering and at Annexure 3 and 4 for the degree holders for advanced Diploma in Structural Designing and Advanced Construction Manangment. These are just for information and can be suitably modified based on specific requirements.

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Re-Engineering Diploma Engineers and Engineer Technicians

*K. K. Agrawal**

Diploma Engineers :

1. The Diploma Enginners are initially deputed mostly and generally to jobs with requirement of Engineering-specific functions irrespective of the discipline of graduation/training or of employment, calling for technical skill qualifications. They need exposure to specifically developed programs to orient them to adopt those skills which are required for the job hired upon. This can be part of induction level program to be conducted by the hiring organisation, if they have mechanism to do it, or by specially promoted Training & Education firms drafted to do it.

2. As these Diploma holders grow up in the service ladder, a stage calls them to be in either Senior Technical positions or in Managerial positions where their skill upgradation is needed.

3. In the Senior Technical positions, they need 'Relevant Higher Technical Skills' along with 'Managerial Skills', 'Man Management Skills' and 'Organisation's Policy Identification'. This calls for "Re-engineering" exposure to a "very well designed training program".

4. For the Managerial positions, they need exposure to :

   a) Business Processes, Methods and Management,

   b) Project Planning, Monitoring & Management,

   c) Procurement Management,

   d) Quality Assurance, Management & Monitoring,

   e) Aspects of Safety Management,

   f) Environmental planning & Management,

   g) Business and Mercantile Law covering Labour laws, Contract laws, Arbitration and Disputes Laws Etc.,

   h) Man Management including Behavioural Psychology & Personality Development, Motivation and Leadership,

   j) Financial Management & Accounting and

   k) Decision Making & Organisational Aims and Policies.

5. The subjects covered above for training the Managers call for developing a compressed and focussed training capsule carefully designed covering more than entire syllabus at Bachelor of Business Administration program of 2 years.

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6. The Re-engineering Programs and Training modules need to be developed through specialist groups either within organisation or outside in consultation with senior professionals including assurances of useful conduct of the programs.

7. The example in respect of Civil Engineering Diploma holders employed on Realty and Building Construction may be seen at Annexures 1 and 2 in my paper recently approved by ECI for presentation in the conference.

Engineer Technicians :

1. They are the basic technically qualified skilled technician's work force whose practical skills are to be developed for achieving 'Quality'. The induction level training programs can comprise of achieving proficiency and quality, as "on the job" schedules.

2. Over the period of time, their avenues of upping on ladder are position of 'Supervisors', 'Asstt. Foreman' and 'Foreman'.

3. These promotions need to associate with them certain programs, for exposing them, covering 'Quality Assurance and Management', 'Inspection and Testing', 'Man Management, Motivation & Achieving Targets' and at Foreman level limited exposure to 'Organisation's Policies'.

At this point I can think of the above.

However, I strongly feel that our country should have many Training Schools to cater to the small and medium size companies who cannot afford to have their own Training Divisions.

The organisations like ECI, The Institution of Engineers (India), CEAI, CDC, National and State Industries Corporations, Engineering Institutions like IIT's, NIT's and various other private and public institutions. What is required to ensure is their Quality of Programs and Efficient Conduct of programs.

There has to be Monitoring and Regulatory Bodies to oversee the Quality of Programs and their Conduct.

Re-Engineering Our Engineers

Dr. Max Babi*

As a technical director in several companies, I have very often interviewed hundreds of engineers, employed them, trained them, developed their soft-skills, created huge awareness in a mind stultified by dark forces like the retrace and wrong values, even a feeling of inadequacy. As a rule, I have been left aghast at the fast erosion of core values in youngsters.

Disappointment after disappointment awaited me during endless oral exams in engineering colleges, till I was forced to change my views from a tendency to blame the students for being shallow, to the whole education system being anachronistic, unwieldy even out-of-touch with reality. Thus it seems like a question of re-engineering our entire engineering education system rather than re-engineering our engineers.

Just as the case of millions of 'missing girls' from a generation disturbs us –the case of missing engineers also should disturb us if we believe in a secure, well-balanced and fruitful future. Embryo examination has helped millions of stupid parents to abort a girl child, but what about them who have pushed brilliant engineers into a much less 'infrastructure building' even infrastructure supporting career like IT or software peddling? Amongst my own close friends, those who may not be more than a decade younger to me, thus nearing retirement, the very familiar expression I hear to my utter disgust is, ' I am not an engineer anymore, I am a software guy…' Truly, electric engineers with Master's Degree even from IIT have not kept in touch with basic engineering skills in their daily rigmarole of an artificial world, a virtual world where management skills, executive duties and targets and delivery dates take supreme position.

What about creativity? What about those wonderful short-cuts and resourceful ideas that an average engineer used to spew forth like a set of fresh Diwali crackers some decades ago? Don't we realize that engineers themselves don't fix things anymore? Today's disposal technology is forcing us to junk virtually everything that breaks down. We go for a more expensive, delicate and short-lived new model. Fixing has become obsolete so who has the time to innovate, or come up with a new idea? We are fast becoming a mindless social block, which believes strongly in here and now –there is no past, there is no future. What you can enjoy today is what matters the most.

Returning to the faulty and obsolete engineering education system, that has no time to encourage the creativity which is the hallmark of youngsters with a scientific or engineering/technological bent of mind, one feels an inhuman sense of what Germans call Schadenfraude. There is no equivalent in English, the ligua franca, and often an expression like 'unholy joy' is used to express this duality of emotions. An example often cited is the Secret Service operatives during Hitler's reign of terror, watching the sub-human torture of a human being and experience the joy of seeing a hated creature being destroyed and at the same time feeling a sense of guilt for being part of an anti-human activity. Sensitive minds who have experienced the world, feel a sense of Schadenfraude on seeing the wilful suppression of creative instincts among the youngsters today. The retrace is precisely geared to do just that. One cannot drop by, one cannot take a breather to let some creative thinking, some innovative

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streak within, become the master of one's life even for a few precious moments. Keeping up with the Jones, keeping up appearances, is like being a part of a marathon that ends only when one reaches a dead end. One stops only when the whole mass of mindless racing participants stops. Or else one gets stomped over, trampled over, thrown by the wayside.

The much-maligned 'semester system' was in all probability, designed to reduce the super-human burden on the weak shoulders of the undergraduates in any engineering stream. However, democracy was also in all honesty, designed to provide the best possible method of ruling the people –but how far it has succeeded, is for anyone else to see. The semester system may have reduced the burden on the engineering student (by comparison the medical students undergo much more rigorous training) but many undesired side-effects have crept in, that the well-meaning pioneers in education never foresaw.

The attention span of this internet generation is said to be a mere three seconds, (that's why surfing the net is called more popularly browsing in the cyber café parlance… browsing does not involve reading, focusing, assessing nor 'registering' of information on the mind) –now give them a subject to master in one week, take a weekly test and leave the short-term memory to take the driver's seat, the long-term memory be damned. In reality, we also strongly seem to be believing, long-term values be damned too. What matters is making more money –though none of us in the long run realize that money is a symbol of collective strength or 'people power' : when cooperation between people fails, money loses value–or else nations would not fail. An ocean of money could never keep a nation afloat for an eternity… even superpowers fail.

Re-engineering our engineers is a big deal. Unless we severely revamp the entire system, a system that is absolutely irrelevant to the needs of the industry, re-engineering individuals is a tall order. The irrelevance of the basic poor quality of engineering education is not glaringly obvious to neither the high profile IT and software industry with its never-ending hunger for more 'techies' but even to the much more level-headed, grounded and pragmatic engineering industry itself too. For the IT and software industry, an engineering degree is a mere passport, much as passing high school is a passport to various technical courses which do not really need engineering skills, problem-solving abilities, basic knowledge of materials and manufacturing technologies and much more.

India has seen a mushrooming of small private colleges that sometimes look rather like a two-bedroom flat converted hurriedly into a teaching institution. It is these 'profit centres' who are usually most eager to admit students with an engineering degree – the quality of education be damned. Unfortunately, management institutes with pretensions to be international centres of excellence also at times indulge in such practices, i.e., compromise the quality, because after reaching a certain level of business –the adage 'the show must go on' applies with a cast iron solidity.

To keep the show going on, the administrator would stress first of all the ability of the student to pay the fees –money comes first, secondly, a graduate degree : whether it is science, engineering or commerce doesn't make much difference and third, the student must be reasonably competitive. Where do we see the impetus on engineering skills here? Even the fundamentals of engineering are usually missing from those who aspire to be hot shot managers. Real-life-managers also admit at some point of their career that they are no longer engineers, they are executives with mastery on management. This is yet another black hole that swallows up our 'missing engineers'.

Industry today in India shows historically that it was traders who invested money in the infrastructure for industry soon after independence. Thus the mindset of top management everywhere has been to reward the managers and keep the engineers invisible. Often brilliant ideas generated by engineers are slyly turned into credit for the managers –inventors, innovators and creative thinkers in the engineering community have never been rewarded in anyway. The traders' mentality that treats engineers like minor flunkeys in a corporate world geared to be money-minting presses, survives, thrives and proliferates.

Re-engineering the system is thus a triply difficult task. We need not only to re-engineer our education system but also the mindset of the industry honchos and even the slightly further but potent community of the business community that can no longer be ignored. This community not only provides jobs, it also rules the trends that make engineering profession what it is today. That's saying a lot in a nutshell. Unless the craze for IT and software slackens a little, an engineering degree would remain invisible, engineering skills remain suppressed or stunted or even exorcised out of a sensible young man or woman and finally, innovative instincts killed. Why do we keep producing millions of copy-masters who duplicate or triplicate work in IT and software that was invented in the US or elsewhere? Why don't we have an IT powerhouse in India that invents solutions which could become proud possessions of Indians, to be bought off by Microsoft or Apple or Oracle in future? Why are we satisfied so easily with a little more money and the need to walk in the shadows? Does a nation of 1.25 billion souls produce less than a fraction of one percent creative thinkers?

What Needs To Be Done :

1. ***Change our mindset first :*** Democracy may be fashionable, perhaps an inevitable evil –but what will stop us from borrowing ideas floated by the much-maligned socialists or communists ?

   Engineers are getting lost in the IT jungle by millions, that the huge brain-drain within –which has to stop. IT can train Arts and humanities students as well, let them. Or create their computer science and IT stream to let engineers alone.

   Russia grew into a formidable power on its inherent engineering innovations and its unique policies that stressed the innovation and invention too much even 50 years ago. Those innovations were bought off by shrewd American business men or houses, and turned into billion dollar spewing behemoths. Logically speaking, that could not have happened if the personal freedom and lebensraum (breathing space) that democracy provides was in reality such a big deal. But it happened, for decades it went on happening. The only possible explanation is that the general climate was favourable then for inventors and innovators. Scholarly pursuits were fashionable. Today our universities see their M.Tech seats go empty, funds remain un-utilized, research has taken a backseat while IT barons are pushing, like black market barons, the quick buck get rich quick policy.

   The desirable mindset can come about only if it is drilled into the innocent minds of school kids. That may be written off as indoctrination by some, but brainwashing works. Most of the negative values we suffer from are fast pushed into the market by electronic media and the cinema. Making money by any means is shown to be a sign of success. We are not elevating the guttersnipes to God-hood, we are lowering ourselves where worshipping the underground life forms may be natural.

2. Re-vamp The Engineering Education System : The system needs overhaul, it is no longer relevant nor useful. The semester system has had its heyday and needs to be replaced with a new system wherein :

   (a) engineering undergraduate students study for 1 year

   (b) next six months they spend in an industry, be it small/medium or large scale and absorb industrial problems, modus operandi, especially the troubleshooting part and production,

   (c) come back to college and find out the theoretical aspects used in troubleshooting, modernization, upgradation, absorption of new technology, thinking out of the box or lateral thinking etc… plus study more.

   (d) before getting the degree, go back to the same industry to reinforce their learning…

   This will make them 'industry-ready' unlike the greenhorns, Our engineering colleges are churning out by the millions, half-baked and half-scared. It's always the on-the-job training that makes an engineer. No engineer remembers what subjects they studied but the ability of problem solving becomes a habit. Every single new assignment is yet another opportunity to cement the new learning that has a practical use.

3. Bureaucracy and hierarchy Are Dead : The British Raj gave us a system for education that was tailored to produce millions of 'babu's to run their empire. Today's babudom is nothing but a pace-retardant and a liability for us all. The bureaucracy practised even today is almost like reciting the Hindu mantras by a Caribbean islander who doesn't even remember the correct words. Rationalizing, saving time or paper or useless profusion of clerks is not encouraged. Hierarchy also we have inherited as an extension of bureaucracy and it is also an anachronistic burden and a waste of time. For better engineers we need minimum bureaucracy and hierarchy.

4. Our Examination System Needs Revamping too : Those who can mug up paragraphs and pages, today, are deemed the brightest. The industry has no place for these muggers whose short memory may be terrific but who have remained as ignorant of engineering as they were when they sought admission. Ideally speaking, an examination system should be able to assess what has been 'understood, assimilated and internalized' by an engineering graduate. The poor-quality teachers have misunderstood their stellar role too, they produce easy questions with pat answers that can occur to the mugging specialists.

An inspired teacher would frame up different questions in every exam with a view to fathoming what knowledge has gone deep into the mind and psyche. These questions cannot be answered by reproducing paragraphs mugged up by the dull student who will never make a proper engineer.

Perhaps an engineering education should not be culminating on an annual examination where mugging up leads to success and the bright, creative thinkers who are real engineers, driven by passion for design, and problem solving, flounder. It would be much better to assess a project work… the projects given to students should be real-life projects, with some industrial use, some bottleneck crying out for an immediate solution. Marks given should consider engineering knowledge and skill (not paragraphs from textbooks mugged up), the ability to understand a problem, internalize it and apply their knowledge and common sense without suffering from limitations of resources, time nor boldness. This topic is fit for a thesis…

"Re-engineering" is A Misnomer

R K Abrol*

At the outset, as multi-disciplinary engineer of 56 years standing with extensive exposure to many branches of engineering, I feel the concept of "Reengineering" of "Engineer" is fundamentally faulty.

Why?

Because, once a person qualifies to be designated "Engineer" by virtue of his professional degree, he cannot be re-processed (Re-engineered) to become "Engineer" once again. That is what the term "Re-engineering" means.

Science and Engineering are inseparable fields of knowledge. One cannot survive without the other. Yet, Scientist and Engineer are fundamentally different in one respect - Scientist is a person with original ideas; Engineer is a person who makes a design that works with as few original ideas as possible.

Engineer is also defined as a person who uses scientific knowledge to solve practical problems.

A person is entitled to designate himself as "Engineer" after acquiring a degree in engineering from an engineering college or university. However, he cannot plan and/or design on the basis of such acquired theoretical knowledge only. He must acquire the requisite expertise by working under the guidance of a senior Engineer in an engineering firm/organization. In addition, he must constantly upgrade his knowledge to be able to apply the latest advancements in science and technology for improving his planning and designing capabilities to be able to independently practice the profession of Engineer. This process of expanding the knowledge horizon is limited not to Engineering profession only. In every profession a degree holder must necessarily expand his knowledge horizon and expertise before he/she becomes competent to practice his/her profession.

Keeping this basic definition of "Engineer" in view, it is obvious that "Re-engineering" of Engineer is a misnomer.

An Engineer cannot be "Re-engineered". He can only expand his knowledge and improve his expertise to become better qualified to practice the profession. For example, in USA an "Engineer" has to acquire the title of "Professional Engineer (P Eng)" to be able to practice the profession. He does not have to be "Re-engineered" to attain this status.

Of course! An Engineer's knowledge and expertise can be updated and/or diversified to widen his sphere of professional capabilities through continuing education courses and other such activities. This does not, by any stretch of imagination, be called "Re-engineering"

The term "Re-engineering" can be appropriately applied to engineering products which can be reprocessed (re-engineered) to acquire a different shape and/or size. But to apply the same terminology to "Engineer" (he or she) is most inappropriate.

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When a (medical) doctor expands his knowledge horizon and acquires new expertise, such as MD, within the sphere of medical profession, it would be absurd to say that it is a process of "Re-doctoring" a doctor. Can a fresh MBBS degree holder starts practicing the profession with supplementing his/her basic degree with additional knowledge and expertise?

Similarly, when an Architect acquires additional skills, we do not say it to be "Re-architecturing" an Architect. An architect can not start practicing the profession unless and until he/she acquires additional skills.

The same applies to other professionals like Chartered Accountants and Lawyers. Should we call them "Re-engineering of Lawyer" or "Re-engineering of Chartered Accountant ?

Acquisition of additional skills is essential for all professionals before they can start practicing their profession.

I strongly feel that the title of the proposed ECI Seminar is not appropriate.

Re-engineering ENGINEER

S Ghosh*

ENGINEERING is to contrive make and happen something tangible which is useful to the humanity. The community who does so and have to have special skills to do so are known as ENGINEERS. Re-engineering of ENGINEERS – would be remaking these ENGINEER's skills and thinking to act in an appropriate manner rather than carry on mindless repetitive action they have been following.

The re-engineering objectives is to upscale the skills to respond to emerging scenario in the world and to address changing needs of the society as we go along the time horizon.

An Engineer acquires his basic knowledge of fundamental principles of nature and the forces those controls, causes things to happen ("physics") in schools, colleges, universities. They also learn materials, methods and tools as to how to make things happen. Their skills need to be sharpened and developed while they pursue their working life - may be engaged in practices such as - teaching, research or working in industries or in the governmental or regulatory bodies.

The process to be effective has to happen during the initial years as they enter the working life (1 hint at the Initial Professional Development – IPD) and periodically as they go along their professional life (I mean they need to pursue Continuous Professional Development – CPD - programme).

Now let us look into - what are the changing needs of the Society, why we talk about re-engineering.

Are we not all concerned with the fact that –

- While the population is growing.
- The non-renewable resources (such as Space – land and water mass; Water quantitatively & qualitatively; Air qualitatively; Energy source) used by humanity and which occurs naturally in our planet earth – is limited.

Simple equation – if the population grows and resource availability remains constant – the per capita resource availability will be reducing – a pointer to reduction in quality of life. But that's not acceptable. The demand continues for a better life style, better quality of life.

Is it not a Paradox ??

So the onus is on - "Innovativeness and Re-engineering" of things to do, way to do and the mind set of people who does it.

So much so is the concept and philosophy.

If we come down to real life and to the Domain of Engineers, we see the following emerging scenarios –

The society wants the engineering community to act in a manner that effects

- Enhancement of quality of life
- Optimum uses of resources

* *Vice President, IASE & Immediate Past President, CEAI*

- Recycling resources used enabling their reuse
- Energy efficiency
- Judicious use of financial resources
- Optimal benefit to the entire cross-section of the society – poverty alleviation and empowerment
- Protection of the environment and the biosphere

  The accusation has been that we the Engineers are not in sympathy with nature, do not strictly adhere to sense of morality and ethics – being under pressure of being influenced by technology and other compelling reason that are affecting our fellow beings, the society at large and our planet earth.

ENGINEER need to act sustainably and in responsible manner and that's the right thing to do. Sustainability is an issue of very central concern in our built environment.

We need to appreciate that the skill sets of Engineers of Today are not just bound by his knowledge of basic physics, material science, theory of structures and machines or his TECH - Wizardness – but also he has to master other softer skills – as "tributary to main stream engineering". Just not the use of multiplicity of analytical models he knows or learnt but his knowledge and "Integration of disciplines" need to improve if the ENGINEER has to enhance the value of services being brought to by him in any projects he gets involved in.

These will only improve the standing of the ENGINEERS in the society.

I envisage the Engineers of Today to be able to understand and have appreciation of the –

- Usage of the end products (Functional Requirements of what he is to produce)
- Financial Constraints - Budgets and other Commercial Requirements
- Project Execution Time

He also must know the -

- Legal and Statutory Provisions guiding his work
- His Obligation to the Society and Accountability
- Risks and Rewards of his work

He should have full knowledge of the -

- Codal Provisions – IS/BS/NB Code/ISO et al
- ISO – Quality Assurance Needs
- Safety and Health Requirements

associated with the project he deals.

Needless to say, all above are besides the basic knowledge he inherently supposed to possess such as ability to do –

- Structural Solutions taking into account structural stability, durability, aesthetics
- Analysis and design of structures – software applications; and
- Follow the global shift from deterministic models to probabilistic models and reliability based design criteria.

He also must have and acquire full knowledge on –

- Sustainable use of materials
- Relevant Environmental Concerns
- Construction Techniques

He should also have -

- Skills for programming and control of project implementation; and the
- Routes and forms of construction contracts

Most importantly he must have -

- Effective Communication skills; and
- Inter-personnel skills - which are

a must to be able to express his view points and make others understand and appreciate the same

So far so as to what I conceive of and what I expect from an Engineer of Today.

Now the question is – when and how he acquires his complete skill sets.

Undoubtedly – he has to complement the skill sets he acquires in his schools/colleges – by what he learns during his professional career.

To address these issues – should we not firstly have a good look into our curriculum profile – that's been prescribed in the colleges/universities and the methods followed therein. Surely these are being addressed – but not perhaps sufficiently.

Most importantly the various professional bodies – the likes I belong to – have very important roles to play to reshape our professionals through pro-active programmes they design for their members and even offering support to non-members. The professional bodies have great obligations and must fulfil these. I know they are trying to address these challenges – and that fact needs recognition by decision makers. The Society and the Regulatory authorities need to take them into cognizance.

Theme Papers

Re- Engineering Engineers

K.K. Kapila*

I feel deeply privileged to be with you at the 6th National Conference with the theme: **Re- Engineering Engineers** being organized by Engineering Council of India, the premier body of engineers working for the advancement of engineering profession encompassing various disciplines and for enhancing the image of professional engineers.

Re-engineering can be described as, the fundamental rethinking and radical redesigning of operations, manufacturing and business processes, in order to achieve significant improvements in performance, efficiency and quality. To improve efficiency and performance in engineering design and manufacture, a variety of strategies may need to be employed. These strategies will normally scrutinize, the tweak and redesign all the contributing elements of an engineering activity, except the Engineer.

Re-engineering has emerged as the basis for many recent developments in management. The cross-functional team, for example, has become popular, because of the desire to re-engineer separate functional tasks into complete cross-functional processes. Also, with the advent of developments in the information system, it has become possible to integrate a wide number of business functions, such as:- Enterprise Resource Planning, Supply Chain Management, Knowledge Management Systems, Groupware and Collaborative Systems, Human Resource Management System and Customer Relationship Management systems, all steming out from the re-engineering theory.

In training as well as career development of engineers, the recognition of cognitive lateralization is seldom considered, and yet it is of prime importance. Much of the engineer's creative ability is cerebral based and involves design and visualization. The development of the engineer's spatial ability has a significant effect in all engineering and design activities. Improving an individual's visualization/spatial ability skills, increases creative and innovative capability, and enhances performance encompassing engineering, design, mathematical and CAD activities. It, therefore, makes good engineering and economic sense to consider the reengineering of the engineer, in the context of enhanced performance.

Courses in the Engineering Colleges such as industrial engineering, electronics and computer science have enjoyed their birth, growth, and maturity during last thirty years or so, and have supported the new market requirements. The more recent past has seen a move to include multi-media technology as a generic skill. Now a days, engineering students are less interested in theoretical principles, related to mathematics, concepts and researched courses. Furthermore, government, employers and planners, are seeking different attributes from engineering graduates.

** Chairman & Managing Director, ICT; President, Consulting Engineers Association of India (CEAI) and President, Indian Buildings Congress (IBC)*

The engineering graduates of the future are expected to exhibit totally different range of skills from their forebearers. The workplace for engineers often demands communication skills more important than high level of mathematics, group working skills more important than academic individuality, and a commitment to life long learning and continuing professional development, in most cases, offers more to employers than a theoretical contribution to research focused projects and developments.

Students have become more thoughtful and focused about their career aspirations. They demand more opportunity to enhance their educational development than has ever been in the past.

Traditional engineering programs contain significant elements of the curriculum which the graduate engineer will seldom use. Mathematical excellence seems an obsession of engineering programs, however, actually this needs a much less demanding level of mathematical ability. There is a need to convert the curriculum programs. The subjects to be introduced and emphasized should be such that are relevant, and purposeful in field application. The engineer of the future must exhibit a range of skills and experience, which differ immensely from those of the past. New paradigm of environmental sustainability and social concern are emerging important issues, for which, engineers need to be well equipped.

Redesigning the portfolio of syllabus in the Engineering Colleges has to be very consciously done, keeping the student's aspiration and employer's demand in view. Developing group and team working abilities, project management and other generic skills for better employability should be the central focus of our programs. This should be coupled with the development of a flexible learning environment where attention to pedagogic integrity is inculcated in training and development programs. Engineers need to be trained and developed, to be independent learners. In so doing, emphasis has to be given to academics interwoven with peer assessment, integrated development, measurement of learning outcomes, goal setting, flexible learning and employment skills.

There is a need to recognize the working culture, and introduce new teaching and learning practices. Today, introducing a culture change together with the convergence of several other factors in the same period of time poses a major challenge.

Another trend, which is being observed with concern, is the shifting of Engineers into areas like finance, marketing, human resource development, and so on. Undoubtedly, there is a need to have competent professionals to work and cope with the enhanced demands in these areas, at the same time, it is not prudent to lose the bright engineering graduates from applying their knowledge and skill in the working of engineering design, planning and implementation of projects. The employability and value of financial package obviously attract bright engineers to work in areas away from the engineering profession. It is, therefore, necessary that the industry and employers, must consider making the package of engineers in their own field more attractive and rewarding to restrain the engineers from moving out of engineering. There is a need to develop a certain sense of pride amongst engineers to remain working in the engineering profession for its growth, development and sustainability.

Engineering Colleges as part of their teaching need to introduce new skills including communication and Information Technology, and develop the urge to keep learning even after leaving the portals of the institute. Alongwith the major engineering subjects, the following softer skills also need to be developed :

- Personal skills such as the ability to improve own learning and action planning.
- Interpersonal skills such as working with others.
- Communication
- Literacy
- Information technology skills.
- Problem solving including critical and lateral thinking.
- Reflection and objective reasoning.
- Positive attitude to change including understanding of the arena of work, politics and society.

It is a known fact "Student learns more effectively when they are actively involved both in the learning process and in the processes of the discipline. Student and young Engineers should be given increasing responsibility for taking charge of their own studies" and that "Courses should be open-ended", constructive, inventive and investigative together with assignment work involving groups of students. Some very hard decisions have to be made when deciding the philosophy, aim and objectives and thrust of new engineering programs.

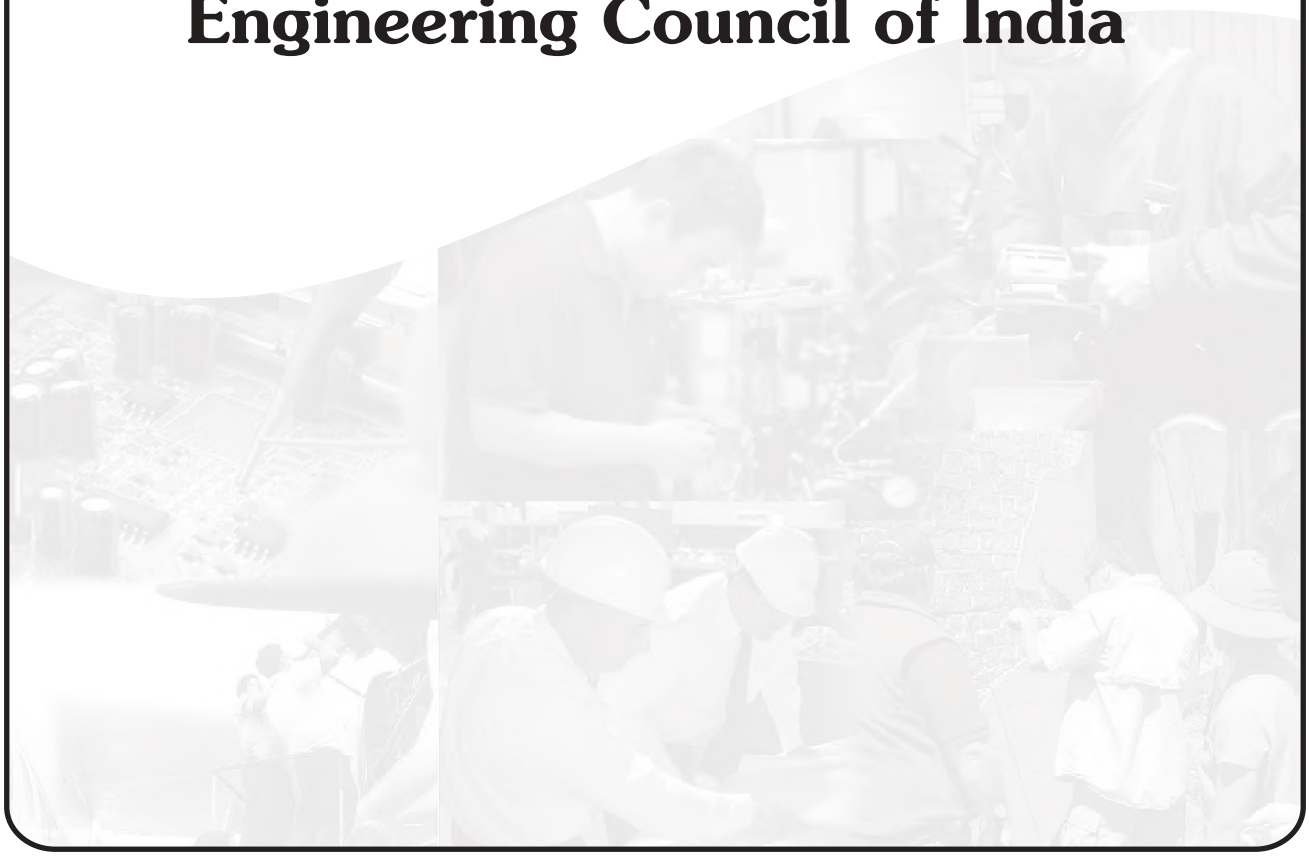
Any broad scheme, which is developed, must be able to efficiently support a number of programs by sharing learning material (courses) from a limited pool. The broad scheme, therefore, should address and embrace:

- Unsatisfactory attrition rates.
- The national changing requirements for registration as a Chartered Engineer.
- A need to manage and control faculty input to course delivery within the confines of what is economically justifiable.
- A clear requirement for a significant staff development initiative so as to cope with the industry challenges.
- The need to move away from teacher led activity to facilitating and supporting the learning process.
- Encouraging and developing skills within students, which allow them to become independent learners.

- Promoting and developing generic key aspects of sustainable employability i.e. team working communication skills, presentation skills, etc.
- Accommodating the realization that the student expectations will increase as and when, they are required to contribute financially towards the cost of their higher education. Flexibility of learning is supported through the adoption of open and distance learning methods.

In summing up, I would like to point out that in the changing paradigm, there is a need to look at the syllabi being followed at the Engineering Colleges, the pedagogy of teaching, introduction of softer skills alongwith the engineering subjects, inculcating a habit of learning as part of continuing education, developing a global outlook, keeping track of political developments, develop leadership skills, which will enable engineers to come out of their shell, and play a greater role in the development of infrastructure for the benefit of the society.

About
Engineering Council of India



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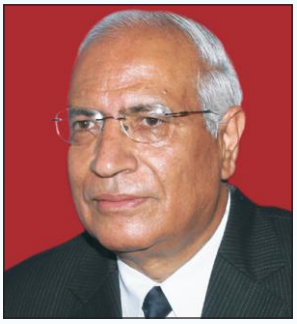

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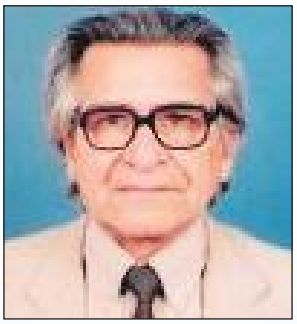

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Mr. P. N. Shali	Director Engineering Council of India

Engineering Council of India

ECI has been formed by coming together of a large number of professional associations / institutes of engineers. The present members are :

1. Association of Consulting Civil Engineers (India)
2. Broadcast Engineering Society (India)
3. Computer Society of India
4. Construction Industry Development Council
5. Consultancy Development Centre
6. Consulting Engineers Association of India
7. Indian Association of Structural Engineers
8. Indian Buildings Congress
9. Indian Concrete Institute
10. Indian Geotechnical Society
11. Indian Institute of Chemical Engineers
12. Indian Institution of Bridge Engineers
13. Indian Institution of Industrial Engineering
14. Indian Institution of Plant Engineers
15. Indian National Group of the IABSE
16. Indian Society for Non-Destructive Testing
17. Indian Society for Trenchless Technology
18. Institute of Urban Transport (I)
19. International Council of Consultants
20. The Aeronautical Society of India
21. The Indian Institute of Metals
22. The Institute of Electrical & Electronics Engineers, Inc., India Council
23. The Institution of Electronics & Telecommunication Engineers
24. The Institute of Marine Engineers (India)
25. The Institution of Surveyors

Engineering Council of India (ECI)

Objectives

The main objectives of ECI are to work for the advancement of engineering profession in various disciplines and for enhancing the image of engineers in society. To this end, ECI will be focusing on quality and accountability of engineers.

In the emerging WTO/GATS environment, mobility is becoming an important issue. Mobility of Indian engineers for delivering engineering services in other countries will be hindered unless expertise of Indian engineers is recognized and accepted at the international level. Conforming to internationally laid down norms is essential also for protecting employment of engineers in internationally funded projects, multinational corporations and large companies in India.

According to its Memorandum of Association, the objectives of ECI are as follows :

1. To promote the science and practice of engineering for national development, collectively along with constituent members.
2. To encourage engineers to serve the needs of the society.
3. To promote advancement of education of engineering in the country.
4. To promote the practice of continuing education and training to upgrade the quality of engineering professionals.
5. To identify and undertake activities of common interest to the engineering profession.
6. To encourage inventions, investigations and research; and promote their applications for development of the national economy.
7. To identify and undertake activities directed to enhance prestige of engineers in the country, and to secure their rightful place at various levels of planning, administration etc.
8. To promote steps to attract bright persons of the younger generation to the engineering profession.
9. To assist Associations/Professional Societies in normalizing criteria for membership so as to make these nationally equitable and internationally acceptable.
10. To establish a common "Code of Ethics" for professional and consulting engineers adoption by Association/Professional Societies and to evolve the strategy for its enforcement.
11. To interact with the government at State and Central levels and help adoption of policies for betterment of the engineering profession.
12. To represent engineers and engineering professionals of all disciplines, at National and International levels.
13. To maintain a Natioanl Register of "Professional Engineers" and a National Register of "Consulting Engineers" who are engineering organisations employing professional engineers where principal occupation is the independent practice of engineering.
14. To acts as a Nodal Body, representing India, for bilateral/Multi-lateral recognition of "Professional Engineers" and "Consulting Engineers" on mutual and reciprocal basis.
15. To identify and encourage the implementation of best practices for the development and assessment of engineers intending to practices for the development and assessment of engineers intending to practice as professionals in domestic as well as foreign markets.
16. To standardize criteria to be adopted for according status of "Professional Engineer" and "Consulting Engineer" and to accord licence/accreditation to practice engineering in India.
17. To identify major engineering disciplines in which substantial cross-border mobility is expected and to

cater to those disciplines in which substantial cross-border mobility is expected and to cater to those disciplines in ECI's policies, practices and their registers/sub-registers.

18. To identify barriers to professional engineers' mobility and to develop and promote strategies, to advice and, if required, assist Central and State Government Departments, in managing those barriers in an effective and non-discriminatory manner.
19. To develop mutually acceptable standards and criteria for facilitating cross-border mobility of experienced Professional Engineers and Consulting Engineers among WTO signatories.
20. To establish such committees, as may be necessary, for reciprocal joint activities with similar professional bodies in other countries who are signatories of WTO and other related agreements.
21. To network and cooperate with other such international bodies who are engaged in similar activities.
22. To perform any or all other acts, deeds and things, which may become necessary to be performed at any stage to achieve the main objectives of improving the image of the engineering profession and of the professional engineer and to serve the needs of the society.

Tasks

In order to meet its objectives, ECI task include the following :

- Certify the competence of engineers for undertaking professional activities.
- Certify the competence of organisation offering engineering consultancy services.
- Integrate continuous development programme with the certification process to upgrade expertise continuously.
- Lay down norms of professional conduct and take appropriate action promoting and ensuring compliance.
- Join international networks such as Engineers Mobility Forum for protecting the interests of Indian engineers in the emerging international scenario.

Engineer's Bill

ECI has prepared a draft Engineer's Bill for the consideration of the Government of India, which lays down the criteria for the process of registration of Professional Engineers and Consulting Engineering organisations and provide necessary statutory framework for the same. The draft is being processed by the Ministry of Human Resource Development.

Membership

Membership of the ECI is open to societies/organisations of engineers who meet the following requirements :

- having been established statutorily or registered in accordance with law.
- having atleast 100 corporate members.
- having existed for atleast four years.
- the accounts being audited annually.